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The Geographical Journal

Vol. LXIII No. 3 March 1924

# RECENT RESEARCHES ON THE PENINSULA OF CARTHAGE

Comte Byron Khun de Prorok

*Read at the Meeting of the Society, 27 November 1923.*

DURING the winter of 1920, whilst visiting the site of ancient Carthage, I had the opportunity of assisting in the work of Jules Renault, a modest French scientist who was living in the ruins of a Roman villa he had partly reconstructed into a habitation. Death interrupted the completion of Prof. Renault's excavation, and nearly his last words were the desire that I should carry on the work he had started.

Returning to Paris, I spent a year organizing, with the help of the Polish and American colonies of Paris, my first expedition to Carthage.

The year 1922 proved to be very fruitful in results, thanks to the continual assistance of the great Father Delattre, and of Mr. Louis Poinssot, the learned Director of the Service des Antiquités of Tunisia. With the first year's films of the excavations of Carthage I toured the United States as Norton Memorial Lecturer of the Archæological Institute of America, and after a lecture at Harvard University succeeded in raising the funds for the continuation of the work, through the kindness of former graduates.

A most disputed problem is the site of Punic Carthage. A hundred years ago there was no definite idea of its position, as the historian Rabusson placed Carthage at Bougie in Algeria, 100 miles away! Historians and archæologists are now unanimous that the city stood on the peninsula about 16 kilometres north of the modern city of Tunis. But there have been endless discussions confounding the exact position of the first city with that of the Roman city of Carthage.

The Peninsula has a coastline of 41 miles (360 stadia by the estimate of Polybius). It is bounded on the north by the Mediterranean, on the east by the Gulf of Tunis, the south by the Lake of Tunis, and the west by the mountains of the Ariana. Its greatest extent is between Cap Kamart on the north and La Goulette on the south, a distance of about 6 miles. Two tracts of land joined the Peninsula of Carthage to the mainland, the so-called " taeniæ " (ribbons) in ancient days.

From the summit of Cape Carthage one has a stupendous panorama of surpassing beauty unfolded to the eye. It is quite easy to imagine why Dido selected this spot in which to build her beautiful city, and how the Carthaginians of old were inspired with a great sea spirit on seeing the vastness of the spectacle laid out before them, which undoubtedly inspired their maritime ambitions.

To the south beyond "The White Mantle of the Prophet," as the Arabs call Tunis to-day, rise the last spurs of the Atlas Mountains, which form the background of the great amphitheatre that contains Carthage and the adjoining towns.

These mountains were the scene of terrible struggles between Rome and Carthage, and Rome and the Vandals.

To the south, across the Gulf of Tunis, rises the majestic Jebel Bu Kurnin, "the two-horned mountain" so sacred to the Ancients, and on whose "high place" are the ruins of the Temple of Saturn and Baal. This mountain is of volcanic origin, and at its base are the famous hot springs of Hammamlif. These springs are to-day as great an attraction to the Arabs, who actually bathe in the ruins, as they were to the Romans in their time.

From the summit of Bu Kurnin, 4000 feet high, quite a third of Tunisia can be seen. Adjoining this mountain is another peak, the Jebel Reissas, the "lead mountain" of the ancients. Thirty miles south of Tunis is the famous mountain of Zaghwan, from which was drawn the water which supplied Roman Carthage by the magnificent aqueduct, the remains of which are one of the greatest glories of Tunisia. Far out in the Mediterranean rise the twin islands of Zembra and Zembretta, famous now, as in the days of Hannibal, for their enormous prawns. From the ruined watch tower on the summit of Cape Carthage one gazes down on the desolate plains where the great tragedy of the Mediterranean was unrolled.

It is admitted that the site of Punic Carthage is on this Peninsula; but I am convinced, as the result of recent researches made by me, that archæologists are mistaken in thinking that the whole of the first city lies buried beneath the later Roman metropolis.

To-day, on arriving at Carthage, one is immediately informed that the hill crowned by the Cathedral of St. Louis is the site of the temple of Eshmun, and the Punic Acropolis called Byrsa; and that the two miniature lagoons, lying at the foot of the incline, were the ancient Ports. From the very first glance at the site so indicated a doubt came into my mind whether they could have been the base and haven of the great Carthaginian fleets that once nearly conquered the world. It is clearly evident that great topographical changes have taken place: perhaps the most remarkable transformations on any site of such importance to historians and archæologists.

Twenty-one centuries have passed since that terrible siege, the result

of which razed Carthage to the ground. During the last three years our expedition has been excavating and studying the historic ground, that we are told was the site of Punic Carthage. Roman, Vandal, Byzantine, early Christian, and Arab remains we have discovered, as have the great explorers of the past, but not the slightest remains of a Punic edifice has been laid bare. Punic tombs have been found here in thousands and inscriptions by hundreds, but it seems incredible that of a city calculated once to have had between 700,000 and a million inhabitants, and buildings six storeys high, nothing is left of the foundations.

Consider some of the towns which in the late war suffered the greatest destruction: the outlines are certainly to be found in the foundations of the houses, and the cellars, and the roads, which could not be entirely erased. The Romans are said to have burned the city for sixteen days and then "ploughed" through the remains. However, stone cannot burn, and her temples and her palaces are known to have been of gigantic size.

The first important excavations were undertaken in 1837 by the Frenchman de la Malle, followed by the Englishman Sir Greville Temple, and Falbe, the Dane; Sir T. E. Read, the English Consul; then Davis. In 1859 Beulé commenced his celebrated work on the Byrsa. Other explorers were Daux (1866), Von Maltzen (1870), Mr. de St. Marie (1874), Tissot and Babelon and Salomon Reinach in 1884. There have been many other excavators on the site of Roman Carthage, but we need only mention the further names of Gauckler (1903), Merlin, Carton, and that of the Reverend Father Delattre for later excavations. All these works were conducted without any systematic plan. Father Delattre is by far the most illustrious name to be connected with the ancient capital of the Mediterranean. His books, pamphlets, and reviews are known the world over for the last fifty years, and he is still the great spirit of all investigations in this historic land. Punic Necropolis, pagan and Christian cemeteries, temples and basilicas and the amphitheatre have all been uncovered by him. The great Lavigerie Museum shows the result of his efforts.

But what have all these expeditions produced of Punic Carthage? With the exception of the tombs, and a few inscriptions, absolutely nothing! Hundreds of books have been written, and endless controversies raised, but nothing of a definite nature has been proved. One knows less about Punic Carthage to-day than at any time before. Only systematic and profound investigation can pierce the veil of mystery that still envelops the Peninsula of Carthage; the future investigations must be continued in other parts of the Peninsula, and will only attain their result when they shall have been carried to their utmost capacity. My own investigations seem to me to prove that there is a great possibility of a mistake having been made. To present this view, I take as proof the ancient historians, the Arab documentation of the Middle

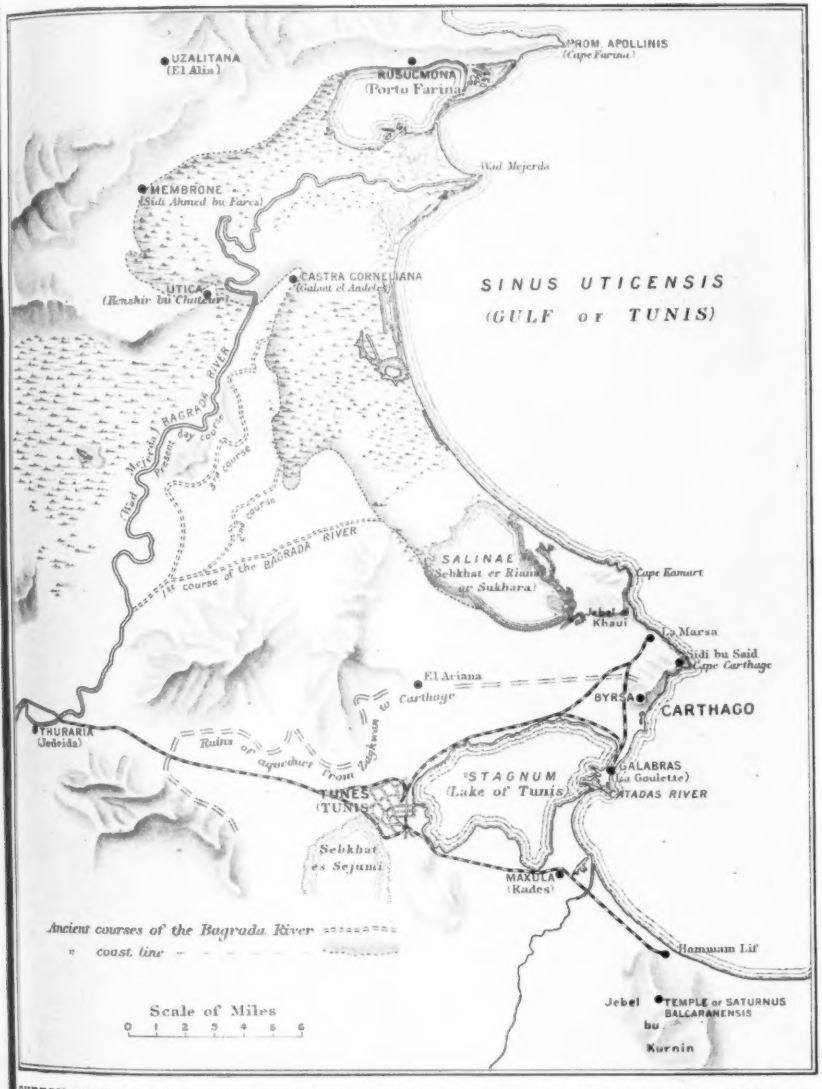
Ages, the research of archæologists of modern times, geographical changes, and the excavations of the last five years.

The basis of the early history is the account given by Polybius of the town of Carthage, for he was present at the siege and its final destruction. The second authority is Appian, who was inspired by Polybius, and then we have Livy, Diodorus Siculus, Strabo, Orosius, Pliny, and Justin. I shall have to quote these authorities in the study of the Mejerda River (formerly called Bagrada); the Sea wall; the Ports; the Byrsa (Acropolis); and the Curse of Carthage.

The Mejerda River, the largest in Tunisia, was formerly called the Macra, the Bagrada, and Baccara. This river has had a strange career, and done curious things. To-day the position of the Mejerda has no direct connection with the history and topography of ancient Carthage, and its course is changing the landscape of ancient Utica, 30 kilometres up the coast. It is my opinion that the past actions of this unruly river have had a great influence on the mystery surrounding the site of Punic Carthage. The alluvial deposit is enormous, varying with the seasons. This river is about 300 miles long, and rises in the beautiful valley of Khamissa in Algeria. It enters Tunisia by the wild gorges of Rebka, and running 30 kms. north-west of Carthage falls into the sea through the Porto Farina, by the ruins of ancient Utica.

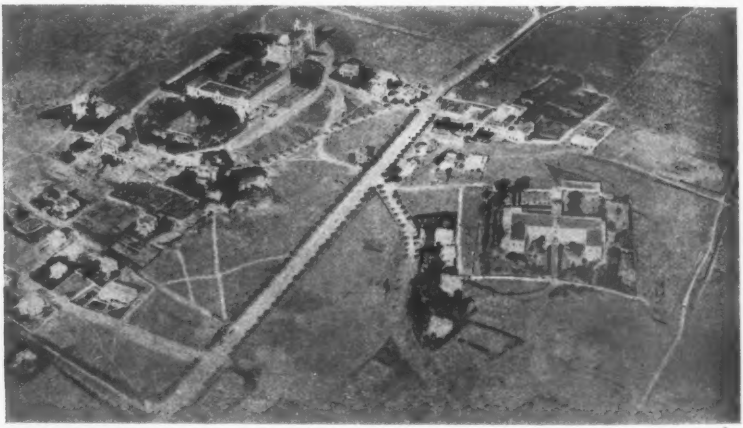
Historians inform us that Hamilcar, the Carthaginian general, with a certain wind blowing—probably the east wind—could await the opportunity of crossing the river by the swift formation of a sand-bar at its mouth, and so surprise the enemy, in much the same way as the ancient Israelites may have been able to cross the extreme fork of the Red Sea when fleeing from the oppression of the Pharaohs. In fact, Hamilcar did make a crossing at the river's mouth by this means, and with the assistance of this movement was able to surprise the enemy. These sandbanks caused many changes in the course of the river, which now flows far from the peninsula of Carthage, but, as we know from Ptolemy, was once only ten minutes from the Punic walls. The Roman remains now called Carthage are fully two hours' walk from what was then the course of this river, whose mouth lay west of Cap Kamart. The bed of the river has thus greatly changed its position since early historic days and the destruction of the splendid city of Carthage, so that important remains may now lie buried under many feet of sand. In my investigations at different places on this side (north-west) of the Carthage Peninsula, I found pine cones and tree-trunks deeply embedded in the sand and earth; and the investigations of Shaw in the year 1743 give evidence of a like discovery.

In Scipio's time the bed of the river was west of Carthage between the rock promontory and sand-hill of Cap Kamart and the hills of El Ariana; and the whole area of the Sebkha Marshes is formed by the




SKETCH-MAP OF THE PENINSULA OF CARTHAGE, FROM THE MAP OF THE SERVICE GÉOGRAPHIQUE, WITH ADDITIONS

GULF OF TUNIS AND BU KURNIN FROM HILL OF ST. LOUIS: LAGOONS IN FOREGROUND



CATHEDRAL OF ST. LOUIS AND LAVIGERIE MUSEUM ON SITE OF ROMAN CARTHAGE

ANCIENT BED OF THE MEJERDA AND SAND DUNES ADVANCING ON KAMART

alluvial deposit of the river. In Punic times we know from the description of Scipio's camp that the northern neck of land joining the Peninsula of Carthage to the mainland was much narrower than at present. This is evidently due to the continuous silting of the sand. The sand from the river has formed great sand-hills at Kamart, under the influence of the Sirocco. I have made measurements of the speed of the advancing sands and have found in a 30-mile-an-hour gale, off the coast, the dunes advance one foot in three hours.

Walking across the sand-dunes I one day observed, protruding at my feet, two or three sprigs of green fig leaves. These belonged to a large fig tree, which had been so quickly enveloped by the advancing sands that the tree itself, during its course of burial, had still retained its life. Over the crest of these sands was a grove of large and healthy fig trees awaiting a similar fate, and close by I observed the remains of an ancient building, and many marble columns half buried in the encroaching sands.

This silent force is gradually creating a geographical change, and slowly covering up the important traces of which I will speak later on. The sand is at present covering the last remains of what I believe to have been a part of Punic Carthage, and so continuing the work of burial commenced by the Mejerda River.

The sea has also made a great deal of change on all this peninsula, but it is very difficult to ascertain at what period it encroached on the land. From the splendid film taken from the air by the late Prince de Waldeck, who was killed on his way back from Carthage this June, it is possible to perceive constructions as much as 100 yards out to sea. This film is a unique documentation in archæology, it being the first attempt to film submarine ruins and record their position. The film and photographs were taken at a height of 1500 feet and again at 400 feet, and are superior to any record we could have made on the sea surface. One can trace not only the ancient sea-wall, which in parts is at a depth of 30 feet, but one can study the topography of the peninsula to an extraordinary extent. The bed of the Mejerda is clearly outlined, the wall of Theodosius can be followed approximately, and even the Roman allotments are defined. Soundings off Carthage were undertaken in 1898 by M. de Roquefeuil, but only in that portion of the coast where Roman Carthage was built, that is between La Goulette and Cap Carthage.

That there was a port at La Marsa is certain from the film ("el Mersa" means a port). The constructions we perceived underwater are of vast dimensions, and stretch from Cap Carthage north-east to Cap Kamart; but those at Cap Kamart have not been marked on any map. There appears to have been a great port here, recalling that of Alexandria, with an opening, and breakwater at right angles to the present village of La Marsa. There was a port here in Arab days,

but the jetty was certainly earlier, either Roman or Punic. We have followed these walls in a small boat as far as Cap Kamart in continuous zigzag lines. From the aeroplane we could distinguish another line farther out at sea at a depth of about 30 feet, but it is difficult to ascertain, until our final soundings are completed, whether this was a part of the first constructions. The authorities of the French Oceanographic Museum at Carthage will charter a special ship to make soundings along the coast to verify the measurements of these constructions for future investigation.

Cicero mentions a fact that historians of Carthage seem entirely to neglect, that the city "which Scipio destroyed was surrounded with ports." From the air one can easily get an idea where ports may have been, in the Sebkha of Sukhra (Salina of the Ancients), at La Marsa, and lastly in the Lake of Tunis (Stagnum of the Ancients). We also photographed from the air the sunken galley found in 1908 by sponge divers, from which a rich spoil of marbles and bronzes has been recovered for the Museum of Bardo. We hope to examine the Gulf of Tunis this winter on the chance of finding traces of other ancient ships, five hundred of which were known to have perished during the Punic wars.

It is well known that Gaiseric, the Vandal king, after sacking Rome in the year 453, returned to Carthage with treasure which included the golden seven-branched candlesticks, and the golden vessels of the Temple of Jerusalem, and that one of these treasure-ships was wrecked off the Peninsula of Carthage. May not the assistance of the aeroplane bring back to the world this long-lost and deeply interesting treasure?

But to return to the much-discussed problem of the ancient ports of Carthage, Appian places the Punic Ports of Carthage to the west of the Peninsula. He speaks of the isthmus being attached to the mainland by a "neck of land" (the Latin "Taenia") leading towards the setting sun.

Polybius mentions also that from the "Cothon" (the headquarters of the Admiral in the centre of the ports) one could plainly see the high seas. Now from the roof of the highest house near the two lagoons, where the ports are placed to-day, it is quite impossible to see the high seas at all—only the Gulf of Tunis is visible. Appian says that after Scipio had built a mole and bottled the Carthaginians up, they cut through to the sea. The account seems to fit better the site west of Carthage.

Shaw, the English historian, in 1743, speaks of the ancient ports of Carthage being covered up by the sands of the Bagrada river, and mentions having seen the outline of a Cothon at La Marsa. Sir Greville Parker corroborates Shaw. Estrup places the ports on the inland lake, with which I agree, but places the Acropolis on Cap Kamart, which I hope to show is entirely wrong. One of the facts that made me look for the ports in other parts of the Peninsula was that Punic tombs have

been discovered in and about the two lagoons in Roman Carthage. The Carthaginians certainly would not have built a port on one of their graveyards, and the tombs were certainly not built there after the port. Another point that I think is all important is that the sea has risen nearly 3½ metres, for the foundations of the Baths of Antonine in Roman Carthage verify this, and if one takes soundings of the sea depth outside of where " the ports " are placed, one learns that there could only have been a maximum draught in ancient times of about 6 feet at the entrance of the so-called ports of Carthage.

We know from Polybius that the ports held as many as 220 vessels at a time. A great maritime people like the Carthaginians must have selected a site larger by far than the supposed one. The Sebkha de la Sukhra is the logical site, a natural harbour protected on three sides by the land. To-day it is only a half-dried lake, filled by the silt of the Mejerda ; and we must remember that the sea was lower then than the Roman ruins found in the lake of Tunis, whose foundations are many yards under water now. Historians relate that the Acropolis Byrsa was adjoining the ports, so that one must look for the citadel in the centre of the Peninsula on the banks of the Sebkha and where the Mejerda river once entered into the sea. Appian mentions the fact that sixty steps led to the temple on the summit. To climb the hill of St. Louis, that is called " Byrsa " to-day, one would need many more than that. This hill, which is about 250 feet high, on which the cathedral is built, is covered with the oldest Punic tombs. It seems hardly credible that the Carthaginians would have built above the dead. In building the cathedral foundations not a Punic stone was found, and this is too strong a fact not to be recorded. The foundations of the Cathedral of St. Louis were dug out to rock bottom. The shafts were on an average 4 metres deep, and there were 89 of them (32 were 2·7 metres in diameter). 3600 cubic metres of earth were removed, and not a fragment of Punic Carthage was found. As Dr. Nathan Davis said in 1860 : " Not a vestige nor even a solitary Punic inscription has ever been discovered on this hill." Neither on the site of the great cathedral, nor of the other buildings, including the monastery, the Chapel of St. Louis (built on the spot where the great King of France died in 1270), were any Punic remains found, excepting only these tombs.

Lately I passed through a number of passages that had been discovered under a certain Mr. Saumagn's property, and can certify that the entire foundations of the hill were of Roman and Byzantine epochs. These foundations and passages touch the solid rock, and prove that no great Punic edifice ever stood there.

Appian also states that the great roads leading up to the Acropolis were bordered with buildings six storeys high : but surely not over the Carthaginian dead ! They say that " Byrsa," the hill of St. Louis of to-day, was the first habitation of the Tyrian colony, yet the tombs on

the Acropolis are of the Punic epoch, 700 B.C. There is no water near this hill, neither river nor wells, nor was there a natural port; so why should the Phœnicians choose it for the first colony?

We must agree with Cardinal Lavigerie, that this spot is not the site of the great Punic acropolis. The "Carthage" of to-day was the great cemetery of the first inhabitants. The Roman conquerors founded a colony one hundred years after its destruction, and built their city on the hills that formed the Punic Necropolis: St. Louis, Borj Jedid, Douimes, and Juno.

Remains can be seen of an ancient Roman road that runs between the Lazaret and the Marabout Sella Salaark, which would have cut right across the lagoons under Byrsa, and this seems to show that they are later than Roman, still more than Punic, age. A field of stelæ has just been discovered at Salambo near these lagoons, and this whole region abounds with them, lying in close proximity to their tombs.

A great trench was made by Salomon Reinach and Babelon in 1880 for a distance of 300 yards, down to the virgin earth, between this so-called Acropolis Byrsa and the "Ports," but not a trace of Punic Carthage was found! In fact nothing Punic has ever been found here, for the simple reason that the first city was not where it is commonly supposed to have been. Carthage was, I believe, in the centre of the Peninsula, with its ports to the north. This Carthage was cursed by a special edict of the Senate, and all attempts at reconstruction were prohibited. Appian says that Cæsar sent three thousand colonists to Carthage, and that they built the new city next to the ruins of the old one. It soon became, under Augustus, the second city of the Roman Empire, and the first Roman colony out of Italy. But the Romans had built even their theatre over the Punic dead.

My own excavations have led to many small discoveries on the site of what was Roman Carthage. On the hillside of Juno, where our excavations have been in progress for two years, we have unearthed seven beautiful mosaics, and a large quantity of mutilated Latin inscriptions, early Christian lamps, coins of the Byzantine, Roman, and Vandal periods of Carthage, potteries of all periods excepting Punic, jewels and iridescent glass. Carthage, being the Phœnician offspring of Tyre and Sidon, has many beautiful specimens of ancient glass, discovered entirely in its Punic Tombs.

In the Museum that we are founding at Carthage, in collaboration with the Service des Antiquités, we hope to have as complete a collection as possible of Phœnician glass, and to be fully equipped to add to the controversy, whether Phœnicia or Egypt produced the first glass. Whilst speaking of glass, I would like to mention a specimen of the greatest curiosity in the Lavigerie Museum discovered by the Père Delattre in a Punic tomb. They are two equal-sized discs slightly magnifying, surrounded with traces of bronze. It seems we are in the presence of a

pair of spectacles! It is said that the Carthaginians had cheque books and paper money. We may still find a fountain pen by which a banker of 500 B.C. may have signed a cheque after having carefully adjusted his *pince-nez!*

On the hillside of Juno I excavated several Punic tombs of about 700 B.C., supposedly the oldest in Carthage. Amongst the remains, between the finger-bones of one of the dead, I found a bronze coin. It was a Carthaginian custom to bury a coin with the dead as a tribute to the god of the nether regions. These coins were invariably of bronze, and were always out of currency at the time of burial. We made shafts also on the hillside of Borj Jedid and Douimes, and, with the exception of the Punic tombs, found absolutely nothing but endless *débris* of the Roman, Vandal, and Byzantine periods.

A notable discovery just made to the north-west of the Hill of Borj Jedid by the Père Delattre is a large deposit of Punic incense burners of about 400 B.C. This discovery of the first Punic statuettes other than those found in tombs was made 2 miles from the site of Roman Carthage. Dig anywhere towards La Marsa, Sidi Bou Said, and Cap Kamart and you may find Punic remains; but one must leave the site of the Roman city, as countless attempts have been made to find the Punic city beneath them, and all have been fruitless. Another important discovery of the Père Delattre this summer was a Punic statue, the only one ever found at Carthage, and that in the garden of the Lavigerie building at La Marsa, 3½ miles from the Carthage of to-day.

The alluvial deposits, with wind and human activities, have made some considerable changes on the hills amongst which we have been excavating. Our mosaics were discovered under 4 yards of earth, and the Punic tombs 1½ yards below them, 4½ yards in all on the slope of the hill. In the hollow between the Hill of Juno and the Odeon the depth varies from about 7 to 18 yards.

If as a result of our historical, topographical, and archæological investigations we are forced to come to the conclusion that the remains of Punic Carthage are not to be found in the site admitted to be that of Roman Carthage, the question arises, Where are we to search for this ancient city and its extensive ports? In examining the ground in the neighbourhood of Cap Kamart and the Sukhra marshes I found interesting clues which will possibly lead to a much more extensive discovery. Here are the ruins of six ancient towers, either watch-towers or light-houses. They were originally circular and about 15 feet in diameter; they are evidently very ancient, and in some cases are with difficulty distinguishable from the rocky surface of the promontory. They are on the slope towards the marshes, not looking seaward. Perhaps 100 feet below the outlines of these towers I observed the remains of a great wall. This was traceable at intervals for 1½ miles, and in many places showed a width of not less than 15 feet. This wall may prove to be the

quay of the Great Ports. In the same neighbourhood, not far removed from the wall as traced, and probably originally protected within it, are a succession of deeply sunken wells. They are large, lined with large blocks of masonry, and were sunk to a depth of more than 50 feet. I descended several of them, and in every instance noted that the water, still plentiful, showed some evidence of a moving surface, which may lead to the conclusion that they all depended on an underground stream. The water is very fresh and pure, and was very evidently extensively used. They are unmarked on any of the published maps of the Peninsula of Carthage, probably because they are difficult to find, and are not in the neighbourhood where archæological investigations have been made. The ever-moving sands are swiftly covering up these important sources of ancient water-supply.

We know that there were insufficient wells in Roman Carthage, and that for this reason they were forced to construct, at a vast expenditure, one of the greatest aqueducts ever built even by those enterprising engineers. Fresh water in large quantities was in close proximity to the position which I think was originally occupied by ancient Carthage. If the Romans, at a subsequent date, built another city in a slightly different spot, it was because of the special curse of interdiction of the Senate on the ancient site, and not because the Romans considered the place chosen by them was preferable. Even to the present day there is no natural supply of fresh water in Roman Carthage.

During the coming winter I intend to continue the excavations begun in this district. Not only am I induced to continue these investigations as a natural result of all the foregoing arguments and facts, but also by a further discovery I have not yet mentioned, which still further drives me to the same conclusion. In the midst of the marshes of the Sukhra were found some corroded and sea-worn masses of stone which evidently, at one time, formed part of a construction then exposed to the action of the sea!

It may not be inappropriate to recall Virgil's description of this city in the *Æneid*. He describes the ascent by Æneas of the hill which overhung the city, *whence he could see the opposite towers*, and as one reads in Dryden's translation:

> "The gates and streets: and hears from every part
> The noise and busy concourse of the mart."

Now the only spot from which he could have heard the din and noise of the workmen in the shipbuilding yards, and gaze down on the roofs of a city without having to enter it, was from the hillside of Cap Kamart, which runs abruptly from the very side of the above walls; it would be impossible from any other part of the Peninsula to look down on any town.

If it were to be argued that Virgil's references to Carthage might mean what is now known as Roman Carthage, then the only hill would

be that of Sidi Bou Said, which is nearly 2 miles from this latter city, and it would have been impossible to hear the city noises.

August Audollent quotes Virgil's poem as one of the prime factors inducing the rebuilding of the city. The romance so fired the imagination of the people as to make hundreds of them desirous of living under the same sun, and in the same lovely surroundings, as once formed the home of the beautiful Dido. That new city soon attained enormous proportions, and in a comparatively short time became the second city of the Roman Empire, and later the second Christian city of the then known world. But in the fourth century it became the prey of the destroying Vandals. Once more it was resurrected by Belisarius, under the Byzantines, to some of its former glory, but fell into utter oblivion under the Arab invasions of the sixth century. The Peninsula of Carthage is now little more than a mass of ruins; but through all this desolation of destruction we still hear calling the voices of Hannibal, Scipio, St. Augustine, St. Louis, St. Cyprian, and other mighty spirits, and it is on this historic ground we wish to continue our labour of restoring to light some evidence of its ancient glory. Growing interest in the work has encouraged me to organize an archæological school at Carthage, with the assistance of the Service des Antiquités. The small museum and a library of North African literature will be opened in April, to be put at the disposal of students, in a beautiful old Arab palace with modern equipment at Sidi Bou Said, near Carthage.

Before the paper the PRESIDENT (the EARL OF RONALDSHAY) said: Our lecturer this evening, the Count Byron de Prorok, is going to conduct us to the French Protectorate of Tunis. He is much to be congratulated upon the public spirit which has led him to co-operate with the Service des Antiquités there in laying bare the ancient sites of Carthage. Our lecturer is one of those who believes that archæology is not the monopoly of the aged, and is gathering together a band of young men whom he is encouraging to carry on the work of research in that most interesting land. He will by verbal description and kinematograph films be able this evening to show us the remains of several civilizations. There is, first of all, Punic Carthage, which dates, approximately, to the year 800 B.C. At some distance are to be seen the remains of Roman Carthage which dates from, approximately, fifty years before Christ. On top of that we find a most interesting period, that of Christian Carthage, and then we come to Arab Carthage. Our lecturer will have something to say of all these great civilizations which have passed over that part of the African continent.

*Count de Prorok then read the paper printed above, illustrated with kinematograph films taken by the late Prince de Waldeck, and a discussion followed.*

The PRESIDENT: I know that Sir Martin Conway is deeply interested in the subject of the lecture this evening, and I will ask him whether he would care to say a word.

Sir MARTIN CONWAY: I seize with pleasure the opportunity of congratulating the lecturer and thanking him for the very interesting discourse he has given us, together with an extraordinarily interesting film. He referred

to it as a first attempt at an archæological film. Well, it may be a first attempt, but it is a very interesting one, and we shall all be delighted if it leads to further developments of the same kind. We are shown films we do not want to see often enough ; it is nice to get one one does want to see. I was keenly interested in what Count de Prorok showed us of the early Christian buildings in North Africa. I have not been in that part of Tunis, though I know the Moroccan and Algerian excavations fairly well. There is no doubt at all that there is much to be learned of the development of early Christian architecture and antiquities from what may yet be discovered in Tunis. I was surprised, as I suppose everybody interested in early Christian archæology is when they first go to North Africa, at the amount of remarkable Christian remains that have been recovered from the soil there. Two or three days ago I was in Edinburgh, and had the first opportunity of seeing the silver, mostly of the fourth century, discovered at Traprain Law. Possibly much of it was of North African manufacture, made in the very regions we have been hearing about to-night. Fourth-century Christian plate which combines classical traditions with the new spirit coming in with the barbarians is a very interesting product, and little of it survives. Barbarian art came ultimately from the neighbourhood of the Crimea. The style travelled across Europe up north into England, down into France, away to Spain, and finally into North Africa. Remains of that Vandal art have been found in this same district. It left a strong impress upon local art traditions which were transferred to the Islamic invaders. Those traditions still survive in Morocco. The other day in Fez I bought what I have no doubt was a relatively modern little bit of jewellery—not more than a hundred years old—made of gold filigree with little green-coloured stones imitating emeralds. That object might perfectly well have been made in the seventh century in France, on the Rhine, or anywhere, in fact, in the early Teutonic world of art. It was curious to find that seventh-century style still surviving so strongly and definitely in the traditions of the Moors to-day. We also found there, and bought, a relatively modern pair of ear-rings, which might have been made in Byzantium in the fourth or fifth centuries A.D. So that, though so much has been destroyed, though so much was swept away by the barbarian invaders and afterwards by the peoples of Islam, yet there still remains a little trickle of influence that has come all the way down the centuries and is still extant among the people. I can only conclude by again thanking our lecturer most cordially for the extremely interesting pictures and remarks with which he has held our attention.

Prof. J. L. MYRES : It is a very great pleasure and privilege to be able to express something of what one feels after hearing a lecture such as we have heard and seeing the wonderful way in which the realities of exploration in French Africa have been brought before our eyes. Archæology, I am sure we have always known, is a science, and a progressive science : in proportion as it advances it stretches out hands to other branches of natural knowledge and makes use of their discoveries and achievements. But I think it is one of the first occasions when archæological exploration has made use of the aeroplane and of kinematograph projection to record discoveries, not only above water-level but also below it. There have been, of course, one or two other examples previously in Mediterranean waters where treasure ships have been identified and recovered, and one realizes, I think, from the Cythera sculpture in the Museum at Athens, for example, as from the specimens of beautiful Greek work which have been shown us to-night, what treasures may be found when submarine archæology gets into its stride.

LA MARSA AND THE SEA-WALLS OF CARTHAGE. (The walls sketched in)

VILLAGE OF KAMART FROM A RUINED WATCH-TOWER, LOOKING TOWARDS PORT OF PUNIC CARTHAGE. (Wells shown by crosses)

THE EXCAVATION OF THUBURBO MAJUS

*Enlarged from kinematograph film by the Prince de Waldeck.*

Enlarged from kinematograph film by the Province de Wallace.

A few months ago we had here a vivid description from Mr. Hilton Simpson of the more primitive elements in the mixed culture of North Africa. To-night our lecturer has approached the North African problem from another point of view; for the history of North Africa, like the history of Italy, might be described as the history of its invasions. The lecturer has shown us something, at all events of the tombs, if not of the actual site of that great adventure, Phœnician Carthage; of the Roman phase of intrusion and exploitation from north of the Mediterranean into the region which the Phœnicians had so nearly annexed; something of the Arabs who, for all their devastation, all their indifference to what had been there before, had a culture and left remarkable monuments of their own. And he has shown us last, but by no means least, something of what our French friends have done to restore North Africa, not only economically and politically, but also from the historical point of view. The wonderful enthusiasm, extraordinary knowledge, and sensitive handling of Father Delattre have been the admiration of archæologists all over the globe. And now Father Delattre begins to hand on the torch, though not wholly relinquishing his guidance and encouragement, to another generation of explorers; and we wish our lecturer of this evening every success.

Sir CHARLES WALSTON: I only wish to express, not only as one of the audience but also as a colleague and fellow-worker in a different region, our gratitude for the very interesting lecture which we have heard; interesting in many ways. Many of us may know something of the Carthage of the Roman period, even of the Byzantine period, and even perhaps all of us have known and looked with admiration upon the work of the great Father Delattre. I wish especially to thank the lecturer for his reference to that truly simple and great man. But finally, he has to many of us, certainly to me, opened out a new prospect of what to learn of the earlier buildings of the Punic phase and perhaps even, beyond the Phœnician occupation, he might find earlier indigenous traces which modern archæology (by its improved methods of excavation) has established. I think we all wish the lecturer every success in his future endeavours, and thank him for the delightful evening he has given us.

The PRESIDENT: Our lecturer must, I think, have formed his own opinion of the measure of our appreciation of his lecture from the spellbound manner in which we have listened while he has unfolded before us this great historical panorama which has carried us back from the Carthage of to-day far back into a past time, to the Carthage of Phœnicia which existed some 2500 years ago. It is hardly necessary for me, therefore, to add any words to bring home to the lecturer our gratitude for the intellectual treat which he has provided us with this evening. We all thank him very much indeed.

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## HASA: AN ARABIAN OASIS

### J. B. Mackie

THE great oasis of Hasa in the north-east of the Arabian peninsula has remained almost unheard of, yet it lies but 50 miles from the coast of the Persian Gulf, and is to-day comparatively easy of access. Of the writers on Arabia, Palgrave, visited the oasis, but his information is now out of date and full of inaccuracies; Zwemer, who also visited it, dismisses it in a page or two, much of which consists of quotations

from Palgrave; and Philby, the most recent visitor to leave on record any description of the oasis, made but a short stay of two days there, and though amassing a wealth of information remarkably accurate for so short a visit, is not entirely unimpeachable.

The approach to the oasis lies through Bahrain, the centre of the Persian Gulf pearl fisheries, and of growing importance as a centre for the distribution of merchandise to Central Arabia and the towns and villages on the south-east coast of the Persian Gulf. It is connected with the outside world by a wireless station maintained by the Indo–European Telegraph Company, and a steamship service providing a steamer each week from Karachi, and every other week from Basra. The Bahrain Islands contain two large towns: Manama on the main island, where the principal merchants live and carry on their business and where the British Political Agent and the British commercial firms are situated; and Muharraq, situated on a small island of the same name and divided from Manama by about 2 miles of water, which, except for a deep channel of about 200 yards' width near Muharraq, is so shallow at low tide as to be easily fordable. Here is the principal residence of the Sheikh, and here the headquarters of the local government.

From Manama to 'Oqair, the port on the mainland whence the Hasa Oasis is reached, is a distance of some 60 miles. This voyage has to be performed in a native boat known locally as "jolibot," but actually very much bigger than our idea of a jolly boat. These boats, which when fully loaded have a draft of only about 4 feet, are used extensively for coastal work along both coasts of the Persian Gulf, and in good weather move freely from the Persian to the Arabian side. They must not, however, be confused with the "bum" or ocean-going boat which is often seen in these parts, and is largely used for voyages between the Persian Gulf ports and Muscat, Zanzibar, Aden, Bombay, and Malabar. These have a deeper draught—in some cases as much as 12 feet when fully laden—and are built with very stout bows, to withstand the waves to be met in mid-ocean. The jolibot in which the passage from Bahrain to 'Oqair is made will probably be built to cater to some extent for first-class passengers, and will therefore have in the stern a platform with a superficial area of some 120 square feet, with an awning which can be drawn over or removed according to the season or the weather. The crossing, it is said, can be performed in seven hours if the wind is fair and the boat in hands of an experienced *nokhada* or master. The writer, however, took twenty-six hours to go from Bahrain to 'Oqair and twenty-two hours to return. Much depends on the time of day at which the start is made. Not even the most experienced master will try to pass at night the *mufraz*, or the bar which almost completely cuts off the deep lagoon lying in front of 'Oqair from the outer sea, and which can at most seasons of the year be crossed only by a narrow and shallow channel. Unless then a start is made from

Bahrain very early in the morning it is probable that a night will be spent at the mufraz. Similarly, on the return journey a night will, if the master can possibly arrange it, be spent at the village of Budaiya' on the north-west corner of the main Bahrain island and some 10 miles west of Manama. Budaiya' is occupied almost entirely by Dawasiris (the tribesmen from Wadi Dawasir in Central Arabia), who provide a very large proportion of the crews engaged in the boats owned in Bahrain; and it is almost impossible to get a Dawasiri master to pass Budaiya' if he can make any possible excuse for spending the night there.

Two things strike one very forcibly on this short voyage. One is that whether by day or by night the master sets his course by a compass, and stars and other natural aids to navigation appear to be but little used. The second is the very high standard of discipline maintained among the crews. The nokhada is the acknowledged master and no one thinks for a moment of questioning his authority, while on a word from him all the members of the crew spring to their places at once, each one knowing which is his own particular job. If the crew belong to the puritanical Wahhabi creed of Islam, it will be noticed that they cannot perform the lightest labour without invoking the assistance of Allah and his prophet. This is especially noticeable when the really hard work of pulling in an anchor or pulling up a sail has to be performed. Then invocations to the Almighty will be used to give the time and enable them all to pull together. An example of what happens may be of interest. Imagine the crew just waking up with the sun and the nokhada having given the order for the anchor to be weighed. On his order being heard each member of the crew will reply with "Inshallah" (if God wills), without which remark no good Muhammadan should, and no good Wahhabi would, ever dream of undertaking to perform any act. All having taken their places on the rope, one of them will appoint himself leader to give them the time. He will probably say "Nasalli" (we pray), while the remainder will reply with either "Al Allah" (to God) or "Ala Muhammad" (to Muhammad) or "Al an nabi" (to the prophet), all getting their pull in together as the first syllable of the reply is intoned. Another variant of the same theme and serving the same purpose is "La ill Allah" (there is none but God). In this case the leader is dispensed with and the executive syllable is the first syllable of "Allah." There are other variants in use, and it is not without interest to note the expressions used for this purpose on the voyage and try to connect special ejaculations with certain actions. If any such connection exists it is very difficult to trace, and it appeared to the writer that they were all used quite indifferently.

'Oqair, the port through which pass most of the goods imported from overseas into Central Arabia, is not even a town. It consists solely of one large khan forming a hollow rectangle with shelters running

round the inside of the walls for the protection of goods and human beings from the elements, and with the centre left open for the camels and other transport animals. There is but one double-storeyed building in this khan, and that immediately over the gate, where is the dwelling and the office of the customs official. In this khan live, besides the official, some four or five men who act as forwarding agents for the principal merchants of Bahrain and Hasa. At the edge of the khan is a square, turreted, double-storeyed building which forms the official residence of the Amir or Governor of the Port.

The Amir's duties are by no means arduous. They consist principally of settling disputes which may arise between merchants and camelmen or among camelmen themselves, and in making transport arrangements for official visitors to Ibn Sa'ud, the Sultan of Nejd, and for any of his officers who may be passing through in either direction. Even so his lot is not altogether a happy one, and he takes no pains to conceal his feelings on the subject. The root of his trouble is that his womenfolk will not come and live at 'Oqair, but remain in the Hasa, where he is able to visit them only at infrequent intervals. He is however an old man, and will no doubt obtain greater contentment as the years roll on. Not so the customs officer, however. An Afghan by extraction but born and brought up in 'Iraq, he is still a young man and a typical ex-Turkish official. In the days when the Hasa province belonged to the Turks he had served them as a municipal official in Qatif, and on the occupation of the province by Ibn Sa'ud transferred himself as part of the province, and has remained in the Sultan's service ever since. Apart however from his irritation at his enforced celibacy, his soul yearns for the society of the towns, and he would gladly, if given an opportunity, return to 'Iraq, though no doubt the lucrative nature of the post he now holds goes far towards making him hesitate to make any change.

From 'Oqair to the nearest edge of the Hasa oasis is a journey of 40 miles across an endless succession of sandhills whose position and configuration are subject to frequent change through the action of the wind. Though only a light wind may be blowing one sees a thin curtain of fine sand being blown from the top of every hillock, and with anything like a high wind the displacement of sand must be very considerable. The route is much frequented and well trodden by the feet of the large caravans which supply the needs of Central Arabia; but even so, owing to this action of the wind, it is by no means easy to follow the track in places, for but a few hours suffice to obliterate entirely the tracks of even a large caravan.

There are two forms of transport in common use between 'Oqair and the oasis—camels and donkeys, and both have their special advantages. For those who are in a hurry and not unaccustomed to camel riding, a good camel is undoubtedly the best form of transport;

but let the tyro unused to such exercise and not hardened to a camel's saddle eschew pace and dignity and take the humbler but more comfortable animal. It is nothing short of amazing to find how many parts of one's anatomy come into contact with a camel's saddle and how quickly that same saddle removes the outer layers of one's skin. An experienced rider mounted on a good camel would have no difficulty in covering the 49 miles between 'Oqair and Hofuf, the chief town of the Hasa oasis, in six to seven hours, but caravan pace is very slow, scarcely averaging as much as 3 miles an hour, and not as a rule doing more than ten to twelve hours a day, except when crossing a long waterless stretch, when the animals will be pushed on to the full extent of their powers. The donkey used on this route is not the common donkey found in all the countries of the middle East, but the big white animal bred in large numbers in Hasa and Bahrain, very largely used for riding and for transport locally, and in considerable demand for export to Mecca and elsewhere. It is very hardy, and possesses a very marked ability to dispense with drinking for long periods. It is not used on the long desert routes from Hasa to the interior, but is used probably more than the camel for carrying passengers between Hasa and 'Oqair or Qatif, the other port through which the oasis is supplied, but which necessitates a land journey of 100 miles instead of 50. They travel faster than the ordinary camel caravan, but not nearly as fast as the riding camels, and can cover the distance from Hofuf to 'Oqair in twelve hours. In the hot weather the journey is best done by night, and then a donkey is far preferable to a camel. The donkey's saddle is such that the rider can easily sleep as he goes with little or no risk of falling off, but for any but a skilled rider to sleep on a camel is a virtual impossibility.

A fast camel performing the journey in a hurry makes of course no stop between 'Oqair and Hofuf, while a caravan, moving slowly and covering only about 30 miles a day, has to halt for a night *en route*. A donkey, however, normally performs the journey with only two short halts for food and water. Across a quarter of a mile of salty depression immediately outside the khan at 'Oqair, and at the foot of the sandhills, are the fort and well of Abu Zahmul, where passable water is obtainable. All animals will drink their full there before starting on their journey, and will then go on to the wells of Umm Adh Dhir, where a short halt will be made and the animals prepared for the waterless stretch of 35 miles which they then have to cross. About 2½ miles from 'Oqair is a depression named "As Suwwad," where there is a well and where a number of stunted palm trees relieve with their green the monotonous yellow of the sand; but apart from this and the few shrubs at Umm Adh Dhir there is no vegetation at all between 'Oqair and the beginning of the oasis. It is said that in the spring after rain the whole desert in these parts becomes covered with grass and flowers, but last winter was almost

entirely rainless, with the result that there was in April no vegetation at all. At about halfway the track descends into a hollow called As Sabkha, some 5 to 6 miles across, the soil of which is strongly impregnated with salt, which produces an excellent firm surface over which the animals can move much more quickly and easily than over any other part of the journey. On the eastern edge of the hollow is a well of brackish water called Ash Shatar, which is rarely used by camels, and never by donkeys unless they are travelling by day in the summer, when they cannot afford to pass any water however brackish. Thirty-seven miles from 'Oqair one reaches the top of a ridge of sandhills and sees some 3 miles away a line of date palms forming a pleasing variation to the seemingly endless sandhills. The soil now becomes much firmer and composed more of clay than of sand, while signs of fairly recent irrigation and the stubble of recently harvested grain crops are seen from time to time. On the edge of the oasis stands the village of Jishsha, but the donkeys do not stop there. The regular watering-place is at a stream a mile further on not far from the village of Jafar. Here loads and saddles are taken off, the donkeys fed and watered, and allowed to roll in the sand to their heart's content for half an hour before the journey is resumed through the oasis for another 8 miles to the chief city Hofuf.

Without making an accurate survey it is extremely difficult to say what is the shape of the Hasa oasis, or how the various parts of it are connected with one another. Philby stated that it was composed of two portions, an eastern and a western, with Jishsha, Jafar, and Al Fudhul in the eastern portion and Hofuf in the western. Careful inquiries during a sojourn of some sixteen days in the oasis have convinced me that this is not strictly accurate. The Barabar stream, rising in what Philby described as the western portion, irrigates gardens in that portion, and then flows down to form the main irrigation artery of Philby's eastern portion. Along the banks of the Barabar the gardens run without any break, and though in places they are but thin they none the less exist, and so make Philby's eastern and western portions one mass of gardens, and not two separate entities. There is, however, another oasis to the north which is separated from the southern one by a gap of about a mile, and which with some bare patches stretches to 'Ayun, a distance of some 9 miles. Subject then to such corrections as an accurate survey may render necessary, there is good ground for believing that the oasis consists of two portions—a northern, stretching irregularly for a distance of about 9 miles from north to south and containing numerous bare patches; and a southern, composed of two solid blocks of well-watered gardens joined by a narrow neck of cultivation along the banks of the Barabar channel.

The population of the oasis is estimated at about 80,000 settled inhabitants, with a floating Badawin element which may amount to as many as 15,000 in the summer, when they bring their camels and other

animals near the water, while in winter and spring it may dwindle away to nothing. The Badawin belong mostly to the Beni Khalid, the Beni Hajar, and the Mutair tribes, though elements of many other tribes such as Ahl Al Murra, 'Ajman, and 'Ataiba are to be found there. These Badawin live in their black hair tents usually outside the oasis, one of their favourite camping-grounds being round the Ruqaiqa wells near the Khazam fort, on the south-western edge of the southern oasis, while others are usually to be found outside the western wall of Mubarraz town.

The bulk of the settled population is found in the two big towns of Hofuf and Mubarraz, estimated to contain 30,000 and 20,000 inhabitants respectively, though there are also a few villages containing from 500 to 1200 inhabitants each. Of these the biggest are Jishsha, Jafar, which in the days of the Turkish Government was the headquarters of a Nahiyah, Al Fudhul, Julaijila, and Munaizla. It is noticeable that there are no isolated residences among the gardens. Every one lives in the towns or villages, all of which are walled and easily defensible. This is a relic of the past when there existed complete lack of security, when the Turkish Government was much too weak to afford any adequate defence against organized raids from the Badawin living outside the oasis, or to ensure the security of the individual within it. To-day with Ibn Sa'ud ruling the land the state of public security is remarkable. The road between 'Oqair and the oasis, which in the old days was perpetually raided by the tribes living near it, and which was never safe even for well-armed parties, can now be traversed even at night by the unarmed, while within the oasis there is complete security of life and property, and people move about unarmed at night without any anxiety or fear.

The population of the oasis is entirely Mohammedan by religion and, almost to a man, Arab by race. The only exceptions are a few Turks, ex-officials and soldiers, left behind when the Turkish administration passed away. Most of the Arabs are Sunnis of the Hanbalite creed, though there is a considerable sprinkling of Shi'ahs, mostly descendants of Baharina (Bahrain Shi'ahs) who settled in the oasis long ago, and have now lost touch to a large extent with their original stock and regard themselves as Hasawis. The Wahhabis, the followers of the puritanical creed which flourishes in Central Arabia, and whose Iman or titular head is 'Abdur Rahman, the father of the Sultan of Najd, and by the organization of whom into a standing army the present position of Ibn Sa'ud has been won and is now maintained, are but little in evidence in Hasa except when Ibn Sa'ud himself is in residence there. The strict tenets of this creed with its insistence on long and ceremonial prayers to be said strictly at the appointed time, its severe strictures against the use of tobacco, and its narrow interpretation of the written word of the Quran—ill suited to the requirements of modern commerce and to free intercourse with other people—made little or no headway among the

more Bohemian and less fanatical population of the Hasa oasis. Here are to be found the agents of Bahrain firms, many of whom have visited India on business, and realise the incompatibility of Wahhabi doctrines with present-day requirements; and there seems little or no reason to suppose that Wahhabism will ever gain a very firm hold here. Further, one of the most important requirements of the Wahhabi creed is that its followers should be at perpetual jihad or holy war against the infidels. Such a demand suits well enough the temperament of the nomad Badawin, who possesses no settled home and no immovable property, and to whom raiding, counter-raiding, and looting are the principal diversions in an otherwise uneventful existence; but it makes no appeal to the dwellers in the oasis who possess houses and gardens which require constant attention if they are to produce the income expected from them, and who, accustomed to a life of ease and comfort, cannot view with equanimity the hardships which desert warfare necessarily entails. The people of Hasa frequently refer to the "Ikhwan" or the organized Wahhabi army in terms of the greatest contempt as "Budus," savages, and in this they receive some encouragement from the attitude adopted towards the Budus by Shaikh 'Abdullah ibn Jiluwi, the Amir of Hasa.

Ibn Jiluwi is an interesting character who certainly deserves a moment's attention. A relation of Ibn Sa'ud, he was one of the small body of faithful attendants who accompanied him on the fateful morning in 1901 when he entered Riyadh in the darkness, waited for the governor to emerge from the fort, murdered him and his escort, and regained his family's capital for the Sa'ud dynasty amid the acclamations of a people tired of the rule of Ibn Rashid, the Amir of Hail, and only too glad to receive back their ancestral rulers. Ibn Jiluwi, having been the Amir of Qasim, was appointed Amir of Hasa when Ibn Sa'ud occupied it in 1914, a post which he has retained ever since. He lives in the citadel at Hofuf and only on very rare occasions emerges, but yet he is known, respected, and feared throughout the whole of the area under his rule. His judgments are based on no written code of law, but on customary tribal law modified as his own judgment thinks necessary, and in all cases he endeavours to make the punishment fit the crime. In the early days of the Ikhwan they, imagining themselves to be the special favourites of Ibn Sa'ud and therefore certain to secure his assistance in any quarrels with the settled population, began to assume a very lordly attitude, robbed and plundered the people of the oasis at their pleasure, and began to make themselves a distinct menace to public security generally. This state of affairs came to the notice of Ibn Jiluwi, who set out to stop such behaviour once and for all, and took upon his shoulders the business of protecting the settled population against the Ikhwan even at the risk of incurring the displeasure of Ibn Sa'ud. As a result he is very properly feared by the Badawin and justly popular in the oasis

SMALL TURKISH MOSQUE IN HOFUF NEAR THE LARGE IBRAHIM MOSQUE

SUQ AL KHAMIS, HOFUF, LOOKING SOUTH, WALL OF KUT QUARTER ON RIGHT, QAISARIYA ON LEFT

'AIN BUHAIRIYA

'AIN AL HARRA

Hofuf, the bigger of the two towns, and capital of the oasis, was the headquarters of the Turkish Government of the Hasa province, and is now the place of residence of the Amir and other Government officials. It is surrounded by a wall built of rough stone and containing several fortified gates, by which alone the city can be entered or left. The principal gates are the Bab al Jishah, through which travellers from 'Oqair enter the city; the Bab Najd in the south-west, which, as its name implies, opens on to the road to the Central Arabian oasis; and the Bab Mubarraz on the north which leads to Muharraz and Qatif. The town is divided into three main quarters, Kut, Rifa', and Na'athil. The Rifa' and Na'athil quarters contain the houses of the merchants, shopkeepers, and indeed all except the Government officials, the personal staff of the Amir, and a few artisans and others who are permitted to live inside the Kut quarter and so make it self-supporting in case of trouble. The Kut quarter is itself surrounded by a stone wall with stout bastions at intervals of about 150 yards, and a moat which, if it was ever meant to be filled with water, would not easily be filled now; it seems improbable that it was ever intended to be filled, but was meant to be merely an extra obstacle to attackers from without.

The Kut quarter occupies the north-west quarter of the town. Inside is yet another walled enclosure to serve as a third and final place of refuge if the two outer walls are carried. It contains the Ibrahim mosque, by far the most striking piece of architecture in the Hasa. Built by one of the earliest Turkish governors of the Hasa province some hundred and fifty years ago, and not, as some say, by Ibrahim Pasha, the Egyptian who overthrew the Wahhabi rule in Arabia on behalf of the Turkish Government, it is the one building in the whole of the Hasa which invites attention, and its broad and well-shaped dome and its tall and stately minaret are the first things to be seen of Hofuf from whatever direction it is approached. Minarets and domes are forbidden by the Wahhabi creed, and as a consequence the Ibrahim mosque is no longer used for public worship, but has now become the Sultan's arsenal. By his courtesy I was allowed to go inside, and even to the top of the minaret, whence an excellent view of the surrounding country was obtained as well as a good idea of the size and general features of Hofuf town.

Immediately round the mosque was the wall of the citadel referred to above, inside which, and at a height of some 25 feet from the ground, ran a terrace with loopholes for musketry fire and with some ten or twelve antediluvian pieces of cannon, some mounted on carriages, but most of them not, protruding threateningly but innocuously through their own special loopholes. Immediately outside the citadel to the west was an open space some 250 yards square, in which Ibn Jiluwi kept some fifty or sixty of his mares, all of them either in foal or with foal at heel. He is reputed to possess over five hundred mares, all of which live out in the various villages or wander with the Badawin

'AIN AL HARRA

'AIN BUHAIRIYA

among the spring pastures, until they are in foal, when they are brought into Hofuf, where he can himself keep an eye on them. In the north-west corner of this open space is a large square fort which on occasions is used as a prison, but which at the time of my visit was used as a stable. On the south side is a small mosque with a peculiar-shaped minaret, while behind it lie the houses of the Amir, his staff, and various Government officials. Immediately south of the citadel lies the Government serai, and next to that the house occupied by the Sultan on the infrequent occasions when he visits Hofuf, and the Wahhabi mosque—a plain unadorned building with no minaret or dome. In the middle of the eastern wall of the Kut quarter is the main gateway, well fortified and with a room over the top commanding a view of the whole town. Opposite this comes in the road from 'Oqair which has entered the town by the Bab al Jishsha.

Outside the eastern wall of the Kut lies the Suq al Khamis, a broad street varying in width from 50 yards in the widest part to 20 yards in the narrowest, and 600 to 700 yards in length from the Bab Mubarraz on the north to the Hamidiya or Town Hall, now used as a storehouse for produce belonging to the Sultan, on the south. The place takes its name from the weekly market which is held here every Thursday. On six days of the week this street will be comparatively empty, most of the work of buying and selling taking place in the big new covered bazaar Al Qaisariya, which runs down the eastern side of the street and has recently been built by a prominent merchant of Hofuf. On Thursday, however, the street presents a very animated sight. From Bab Mubarraz to the Hamidiya the street is packed with Arabs of every type and class. Prosperous merchants, petty traders, keen-eyed Badawin, negro slaves, hard-working cultivators, all jostle one another, while women mingle freely with the men and, secure behind their face coverings, shame with their ridicule or lacerate with their abuse all those unfortunate men who happen to fall foul of them.

All manner of goods are on sale, and where nothing has a fixed price but everything has to be bargained for the clamour can be better imagined than described. Here are two or three sheep brought in for sale by an impecunious Badawin. They will be carefully examined by expert hands, the would-be seller recounting their virtues at the top of his voice and the prospective buyer no less vociferously declaiming against their blemishes. Some twenty persons may examine and bargain for these sheep before they are sold, and no remark throughout the whole period of the bargaining will be made at anything but the top of the voice. At the south side of the suq will be found hundreds of booths occupied by sellers of vegetables, fruit, eggs, chickens, reed mats, baskets, and other produce of the soil. The booth is made of two light frames of reeds usually about 6 feet by 4 feet, made to lean against one another, and covered with gunny bags, reed mats, or a patchwork of odd pieces

of cloth, sometimes with pieces of gunny also included. These booths are very light, and are moved about at the whim of its occupant whenever he wants to move into the shade or when he thinks he sees a site where purchasers are more numerous or trade is brisker. Other shops and booths contain imported goods such as cloth, tea, sugar, matches, and soap, while two or three shops sell and repair firearms, swords, and daggers. As may be expected in a desert town, shops where camel-saddles and saddlery for both camels and horses are made are common, and pottery water-pots are in the summer a necessity in a hot and thirsty land.

Finally mention must be made of the two products for which Hasa is famous, the finely woven black abbas or Arab cloaks, and the graceful brass coffee-pots, both of which are much valued in other markets and exported from Hasa in considerable numbers. Amid this din and amid the gesticulating and jostling crowd will from time to time push their way a camel or two tended perhaps by a small boy almost lost in the crowd some yards behind, or a horseman, while donkeys wander about among the crowd apparently untended and going where they will. The Suq al Khamis on market day presents an animated spectacle well worth seeing, and rarely met with in any other part of the world. Mubarraz, Jafar, and other villages in the oasis have their own market days, but they are small affairs, and not in any way comparable with the big one at Hofuf.

Many of the transactions both in the weekly market and on ordinary days in the bazaar are made on the basis of barter, but there is a recognized monetary system in existence in which a large variety of coins are used. The old coinage peculiar to the Hasa was the "tawila" or long piece, which was a piece of copper with a small amount of silver in it shaped like a kind of V, but having one end straight and the other slightly curved. The coin was one inch long and one-tenth inch in diameter. Along the outside of the straight piece were some marks, quite illegible, but said by some people to be Kufic characters. This coin has now almost disappeared, and it was with some difficulty that I was able to obtain specimens. The story of their disappearance is interesting. For a long time the "tawila" had been the only small change coin in the Hasa, and had always been accepted at the rate of 75 to a dollar. The Turks, however, when under Midhat Pasha they introduced their own coinage into the Hasa, had the tawila assayed and found that it contained an appreciable amount of silver, and therefore ruled that the tawila henceforth should be the equivalent of 20 paras, and that 150 of them were to be equal to the dollar. As a result the old tawilas have been hoarded or have been melted down, and have given way to the comparatively worthless nickel small coins of the Turks.

The standard coin in the Hasa is the Maria Theresa dollar called "riyal." At the time of my visit the exchange rate between dollars

and rupees was 170 rupees to 100 dollars, but the rate is subject to frequent and sometimes to very violent fluctuations. For small change the Turkish 40, 20, 10, and 5 para pieces are in common use. The 20-para piece being accepted at the fixed rate of 150 to the dollar is now called the tawila, and the others 2, ½, and ¼ tawila pieces respectively. Accounts are usually kept in dollars and tawilas. Besides these coins the gold sovereign and the gold Turkish lira are in common use, and big transactions are usually made in one of these currencies. Silver rupees are accepted by the big merchants, especially those who have close business connections with Bahrain, where they are the coins in current use, and somewhat unwillingly in the bazaar; but they are only rarely accepted in the Suq al Khamis and in the outlying villages, and notes are not accepted at all by any but the biggest merchants, and even then only at a considerable discount. Other coins such as Indian and Muscat copper quarter-anna coins and Persian qrans are occasionally seen, but they are not in regular use.

About 2½ miles due north of Hofuf is the other big town of the oasis, Mubarraz, not as big as Hofuf nor so important a centre, but containing some 20,000 inhabitants. It possesses only a small poorly stocked bazaar, in which only the bare necessities of life are to be found. The town appears to have improved very much during the time since Philby visited it. He describes it as "possessing none of the elegance of the capital; its streets are narrow and crooked, its houses of the inevitable limestone are low and unplastered, the wall which surrounds it without bastions, and the gates are featureless gaps." Such a description does not do Mubarraz justice. While it is true that it contains no wide thoroughfare like the Suq al Khamis in Hofuf, yet it must be remembered too that apart from the Suq al Khamis Hofuf's streets are narrow and crooked, no less than those of Mubarraz. To make up for the Suq al Khamis Mubarraz has two open spaces just inside the south wall, joined to one another by a short narrow passage, and here is held on its smaller scale a weekly market similar to that of Hofuf.

As for Philby's remarks regarding the wall and the gates, they are now completely wrong, and neither the wall and the gates nor the bastions look as though they have been built or even seriously repaired during the past four years. A good wall with bastions is now intact on the north, east, west, and half the south side. On the remaining part of the south side it may still exist, but the houses have outgrown it, and so give the town the appearance of being unwalled at that part. Actually the gates in the north and south walls of Mubarraz are in no way inferior to any of the gates in the outer wall of Hofuf. Finally, the houses are, it is true, not plastered with lime, as are many of the houses in the Kut at Hofuf and as is the new Qaisariya or bazaar built since Philby's visit, but they are as a rule mud plastered, and as a rule as good as the houses in the Rifa' and Na'athil quarters of Hofuf. If the official

part of Hofuf is left out of consideration there is little to choose between Hofuf and Mubarraz. Of recent years, however, a lot of work has been done in repairing and rebuilding some of the houses in the official part of Hofuf. The old Turkish serai has been redecorated and extensively altered to make it a residence for Ibn Sa'ud during his infrequent visits to the Hasa, while the old Turkish school almost next door to it has been turned into a guest house.

Opposite the main gate of the Kut quarter Ibrahim al Qusaibi, the leading merchant and landowner in the Hasa, and agent for Ibn Sa'ud in Bahrain, has recently built himself a handsome new office and reception room which is much frequented by the principal merchants of Hasa, and where all the news regarding current events in all parts of the Arabian peninsula can be heard. A feature of both Hofuf and Mubarraz is the almost complete absence of coffee shops. In Baghdad and Basra coffee shops are seen in every street, and in Baghdad, indeed, their number is extraordinary; but in Hofuf there is but one small booth in the Suq al Khamis, which is more a place of refreshment for those who have come long distances to the market than a place in which the people of the town lounge, chatter, and drink. This same lack of coffee shops is noticeable in Bahrain also, where none but the Persian element make use of them. This tends to show that the coffee shop is not of Arab origin, and it seems probable that it is an importation from the continent of Europe through Syria.

It will be asked how it comes about that this big oasis, containing such extensive date gardens and other cultivation and able to maintain so large a population, exists in the middle of the desert surrounded on every side by miles of waterless sand, while the oasis itself has but a very small rainfall. The explanation is found in the large number of springs which well up from the bowels of the earth at this spot and supply enough water at all times of the year for the intensive cultivation of the existing gardens, and would with a little trouble suffice for a considerably larger area. The source of this unending supply of water has given rise to much speculation. It is frequently held that the water comes from rain which falls in the high areas in the west of the Arabian peninsula, and flowing in underground rivers, appears again on the surface in Hasa and in and about Bahrain, where similar springs are found, and where much of the drinking-water consumed by the inhabitants is obtained from springs of fresh water welling up in the middle of the sea, in such quantity as to make it possible to take away the fresh water without there being in it any trace of salt. Others have put forward the suggestion that there must be somewhere a hole in the bed of the Euphrates through which a considerable amount of its water disappears, and that it is this water which reappears in the Hasa. The people of Hasa and the Badawin living in these parts would as true Mohammedans regard it as an act of the grossest impiety to inquire

into the origin of the water, and the reason why it should appear again where it does, but, content that things should remain as they are, merely state that it is " min Allah " (from God), and dismiss the matter as having been satisfactorily explained.

There are countless springs of various sizes in the oasis, but there are six which far surpass all the others in size. The biggest is 'Ain Umm as Saba' (Mother of seven), so called because its waters are taken off in seven separate channels for irrigation purposes. Palgrave devotes two whole pages to a description of a visit he paid to this spring, but if it really is true that when passing round the outside of the wall of Hofuf to avoid going through the town he went through tanks and fields often at imminent risk of falling off the narrow causeway on the back of some buffalo weltering in the mud beneath, things have indeed changed very much since he visited the Hasa. To-day there are no gardens actually adjoining the walls of the town on any side, and there are certainly no tanks—if he used the word in the way it is used in South India to mean a bathing ghat—while during the whole of my stay in the Hasa I never saw a single buffalo. The water of 'Ain Umm as Saba', like that of almost all the springs in the Hasa, is warm and said to be warmer in winter than in summer, though this may be only imagined owing to the greater contrast between the heat of the water and the heat of the air at that season.

'Ain Umm as Saba' is just inside the date gardens at the south end of the northern oasis some 3 miles north of Mubarraz. It is strange that Philby, when enumerating the big springs of Hasa, made no mention of this spring which is the biggest of all. Next in size to 'Ain Umm as Saba' are 'Ain Khadud and 'Ain Haqal, close to one another in the middle of well-cultivated gardens about 1½ miles east of Hofuf. 'Ain Khadud rises up from a deep cavity, whose sides are carved into fantastic shapes by the action of the water, which is carried away eastward in a channel 10 yards wide and of an average depth of about 6 to 9 inches. Most of the larger springs in the Hasa spread out into ponds of some 200 to 300 yards in diameter immediately round the spring itself, but 'Ain Khadud is enclosed on two sides by the embankment which carries the main pathway through the gardens, and on the third by a high terrace : it does not at first sight appear to be as big a spring as it really is. Its neighbour 'Ain Haqal spreads out into a big pond from which the water flows off in a stream no smaller than that of 'Ain Khadud.

About ¼ mile due north of Mubarraz is 'Ain al Hara (the hot spring), which also spreads its waters out into a pond. Though named the " hot spring " its waters are not as hot as those of 'Ain Umm as Saba'. This spring being near the town of Mubarraz is much used for bathing, both sexes making use of it. The women make use of such seclusion as can be obtained from reeds at the eastern end of the pool and the bushes which overhang the channel which takes off the water close behind

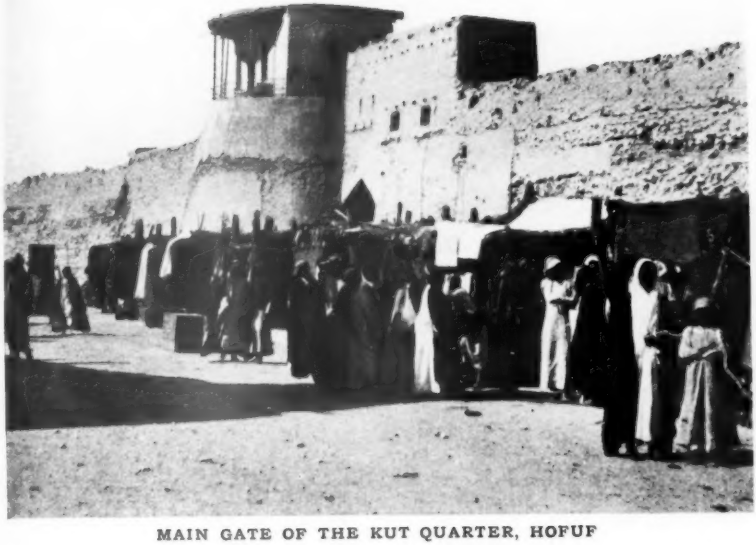
the reed patch. Even so, however, their privacy is very scanty, and though they go as far as to remove their face coverings when bathing there, they do not venture to remove any more of their garments. The principal bathing-places for the people of Hofuf are 'Ain Umm al Khuraisan in the gardens only ¼ mile to the north of the town and near the Mubarraz road, and 'Ain Fuhairiya, about the same distance to the east of the town. Of these the former is the most used. In one corner there is a covered bath for the women, but its use is not at all popular, and most of the fairer sex prefer to bathe in the main pool just outside the covered bath, though by so doing they sacrifice their chance of being able to bathe without keeping all their clothes on. The water in this pool does not look as clean as that of the other springs, owing to its being the place where most of the clothes in Hofuf are washed. 'Ain Fuhairiya is perhaps one of the prettiest of the springs, but it is causing grave concern to those whose gardens depend on it for their water. It is said that the flow of water from it is showing distinct signs of diminution owing to the sides of the spring itself having fallen in. At the time of my visit efforts were being made to dig out the obstructing earth, and stone had been collected with which to revet the sides of the spring when the cleansing process was completed.

There are two other smaller springs which deserve a passing notice. One of these is 'Ain Abu Jamal (the spring which possesses a camel), so called from the popular story that a camel once fell into this spring and was never seen again until some time later it came up in the sea not many miles from Bahrain. Such a story shows that the Arabs, even though they shrink from making any suggestions as to the origin of the water which feeds the springs, yet accept to a certain degree the theory that the springs are not unconnected with underground rivers. The other spring is 'Ain Najim, about 3 miles due west of Mubarraz, and not due north as stated by Philby. Philby is wrong, too, when he says it is in a small mound, for actually it is in a hollow. Possibly what Philby saw in the distance on a mound was a rectangular building built by a former Turkish governor as a military hospital under the idea that the water from 'Ain Najim would be of value in treating the patients. The hospital was little used, however, as the prevailing insecurity not only rendered precarious the position of the doctors and patients actually in the hospital, but also made very unsafe the communications with Hofuf. The spring, whose waters are very strongly impregnated with sulphur, lies in the hollow immediately at the foot of the hill on which the hospital building stands. Palgrave states that previous to the time of his visit the water of 'Ain Najim had been regarded as a panacea for all ruined constitutions, and that as a result large crowds had been in the habit of repairing to it. This congregation at the spring, however, attracted the suspicions of Faisal, the ruler of Riyadh and an ancestor of Ibn Sa'ud, who accordingly gave instructions that the cupola and

baths which had been erected over it should be destroyed and the mouth of the spring choked with stones. To-day the spring has a poor flow, perhaps as a result of Faisal's efforts to prevent the people putting their faith in the water rather than in God. Over the spring itself there is a room 12 yards square with a domed roof and with stone benches running all round the walls, while leading out from this room on the west and south sides are similar rooms, but rather smaller, being only 9 yards square. The buildings however are in bad repair, and resort to the well is not on anything like the scale of the old days. This is the only spring in the Hasa in which there is any noticeable amount of sulphur.

Mention has now been made of the biggest springs and those on whose single waters any considerable areas of land depend for irrigation. There are, however, countless small springs, some supplying water for only a dozen date palms, and others watering as much as an acre or an acre and a half of cultivation. It is said indeed that round about 'Ayun in the extreme north of the oasis there are as many as a hundred small springs, whose surplus water flows into quite a big permanent lake, where grow the reeds used for making the reed mats largely used for houses in the Hasa itself, and in considerable demand in Bahrain and the Qatar peninsula. There is also a marshy area in the southern oasis along the road leading into Hofuf from 'Oqair where rough grass and a kind of broom are the only products. The existence of the lake at 'Ayun and the marsh in the south serve to show how much in excess the water is of the requirements for the area at present under cultivation, and there is little doubt that care in the proper lay out of the irrigation channels would result in a large increase in the cultivated area. Some at any rate of the members of Ibn Sa'ud's staff appear to realize this, and one of them informed me one day that Ibn Sa'ud had under consideration the importation of a qualified Mohammadan irrigation engineer from Egypt to examine the irrigation system of the oasis and work out a scheme whereby more economical use might be made of the water and the area under cultivation extended.

If it be true, as the people of the Hasa contend, that no irrigation engineer ever had any hand in laying out the existing channels or choosing the sites for the heads of the minor distributaries, then the present system does much credit to the Arab's native wit. Much work has been done to carry the water to the places where it is wanted. Masonry dams and other devices for raising the level of the water or for diverting it into smaller channels are to be seen all along the main canals, while it is not uncommon to see the water being carried in masonry aqueducts over the top of others flowing at a lower level. The system of distribution is laid down by no written rules and regulations, but is the result of long years of experience and custom, and no one would now venture to make any change in the existing system without the consent of a very large majority of the people likely to be affected. Each of the main distribu-



MAIN GATE OF THE KUT QUARTER, HOFUF

'AIN UMM AS SABA'

'AIN UMM AS SABA'

NORTH WALL OF MUBARRAZ WITH ITS BASTIONS

'AIN UMM AL KHURASSAN

taries is entitled to so many hours of water each day, and the cultivators on the various channels are responsible for seeing that the regulators are opened and closed at the proper times. There are no officials maintained for this work, which is done solely by the people themselves, nor does there exist any law other than custom which can impose punishment on any person or persons who attempt to break the customary rotation.

In the immediate neighbourhood of the springs the land is usually too high to be watered by flow irrigation, and water lifts have to be made use of. The kind universally used in the Hasa is that known as a "jaliba." A skin, wide at the top but tapering to a point at the bottom, is let down into the water by two ropes, one attached to the top and the other to the bottom. The top rope passes over pulleys and down again to be attached to cattle or donkeys, which draw the full skin up by moving down an inclined plane. The bottom rope passes over a roller on the level of the ground, and from there to the donkeys, and keeps the end of the skin closed so that the water cannot escape while it is being pulled up. As soon as the full skin reaches ground-level the bottom rope automatically opens the bottom of the skin owing to the donkeys' turning at the bottom of the slope and loosening the rope, and the water flows out into the channel which has been prepared for it. In some places five or six such lifts are erected together, and Philby actually saw in Riyadh one of these lifts which was worked by fourteen donkeys, each raising his own skin of water, though none as big as this was seen in the Hasa. Over each water lift there are almost always two or three big trees with thick foliage which provide plenty of shade for both the donkeys and the attendants. These trees are usually mulberry, sidrah, or acacia.

The general fall of the land throughout the oasis is towards the west and south-west, and most of the bigger springs are found near the western edge. It is very noticeable then, in passing through the gardens from west to east, how the water-lifts gradually vanish and flow-irrigation takes their place. When riding through the change does not perhaps strike one, but as soon as a halt is made in the flow-irrigation area one at once misses the unending creaking of the lifts, and it is then that one realizes fully the change that has taken place.

The pride of the Hasa gardens is the "Khatasi" date—perhaps the most famous of all dates. Prized and esteemed in all parts of the Arab world, it forms one of the most important articles of export. Besides these dates there are pomegranates, apricots, and citrons, while experiments are now being made with bananas, mangoes, and other Indian fruits. Of the ground crops by far the biggest is lucerne, which is grown beneath the date trees and finds a ready market in Hofuf: rice, barley, onions and other vegetables, and sunflowers, the seeds and leaves of which are eaten and considered a great delicacy; but as far

as I could gather the seeds are never pressed for oil. Wheat is grown only in very small patches, and when tried is not as a rule very successful.

Apart from the irrigation one thing which strikes one very forcibly in these gardens is the attention which is given to manuring. This is especially striking to one who visits the country after a prolonged stay in 'Iraq, where all irrigation is from the Tigris and the Euphrates, whose waters are so heavily laden with silt that no manuring is ever required. Indeed, in some cases crops have been known to be grown without any preliminary ploughing, the seed being merely cast on to the silt layer remaining after irrigation. In the Hasa, however, the spring water is perfectly clear and carries no such natural manure, and with the earth in constant use—for land is not left fallow for more than a month or two—manuring is essential if the quality of the soil is to be maintained. All the town garbage and stable refuse therefore is deposited in unsightly and evil-smelling heaps outside the walls, and an army of donkeys is perpetually at work removing it to the gardens. I actually met one landowner who had ordered from India a sample of artificial manure to experiment with. Those inhabitants of Hasa who have visited Basra never tire of comparing the hard work which cultivation in the Hasa entails, with its constant manuring and all its irrigation works, with the life of ease lived by the Basra cultivator, whose garden receives natural irrigation owing to the rise and fall of the tide and natural manure from the silt carried in the river water. Throughout the whole of my stay in the Hasa I never saw a plough or any other labour-saving device, all the ground being dug by hand.

Space does not permit of any mention of the history of the Hasa oasis or any description of the people who inhabit it. One story current in the oasis to prove the antiquity of the springs is, however, worth recording. They say that the Jews had a history setting out in detail the forty years' wandering of the children of Israel in the wilderness, and that in their history it is recorded that on one day they moved from Umm as Saba' to Al Qara. Reference has already been made to the spring of Umm as Saba', and Al Qara is a prominent hill some 4 miles to the west of the spring, not a very strenuous day's journey.

Finally, it is perhaps well to correct a mistake into which readers of Palgrave will undoubtedly fall regarding the position of the women in the Hasa. Palgrave says that the veil and other restraints inflicted on women by Islamic rigorism are much less universal in the Hasa than elsewhere. Times have indeed changed since Palgrave's visit. The veil is most strictly enforced in the Hasa, and during the whole of my stay there I never saw a woman's face. Even the negress slaves who in other places frequently go about with their faces uncovered wear a veil in the Hasa, and I was surprised to see the early age at which it is adopted. It is rare that one sees little girls unveiled after they have reached the age of six or seven. Even when they are working in the gardens cutting

barley or lucerne or gathering firewood they still retain it. The veil is made either of a piece of almost transparent cloth rather like limp canvas which covers the whole of the head and the breast, and which can be seen through by the wearer, or of a thick piece of cloth with two small slits for the eyes. This cloth is usually black, but sometimes of a livid purple colour, which gives the women a most uncanny appearance as though they were being strangled.

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## NOTES ON SURFACE MARKINGS IN SPITSBERGEN

**J. S. Huxley, M.A., and N. E. Odell, A.R.S.M.**

(*No. 30 of the Results of the Oxford University Expedition to Spitsbergen*, 1921.)

1. **Introduction.**—The curious polygonal markings to be found on the surface of the earth in Arctic and to a much lesser extent in Alpine regions have long attracted attention, but their detailed analysis is of very recent date. How recent may be gauged from the statement in Högbom's paper (1914, p. 313) that the majority of those who took part in the Excursion of the Geological Congress to Spitsbergen in 1910 preferred to believe that the stone-rimmed polygons represented polygons due to drying, into the cracks separating which stones had afterwards fallen—a view which can easily be shown to be completely untenable

Since that date the classical work of Högbom (1914) has shown us that alternation of freezing and thawing in a cold climate is the prime cause of the appearance of polygonal stone marks. But in spite of his labours, those of Nansen (1921) and others, it is clear that much remains to be discovered regarding them. We therefore make no apology for presenting these somewhat fragmentary observations.

2. **Terminology.**—Considerable confusion has been caused in the past by the application of the term "polygonal marks" to at least two different sets of objects to be seen in the Arctic. These are: (1) the polygons which are delimited by borders of large stones, while the centre is formed of dense sticky mud; the differential distribution of materials and the presence of large stones are invariable characters of this type. Further, these may occur isolated, as circles; whereas specimens of the second type never occur singly. (2) The polygons separated from each other by cracks, and showing no differential distribution of fine and coarse material between centre and periphery; in these, large stones are absent or rare and accidental.

General terms that have been employed for both types are, in German,

"Polygonboden," "Rautenboden," and "Rautenfelder"; in Swedish, "Rutmarken" (first used by Kjellman in 1882; Wulff, 1903); and in French, "Sols polygonaux."

The first type is by the Germans called "Steinnetz," the second "Zellenboden" (Högbom) or "Spaltennetz." English terms making this distinction clear are not in general use. We propose here to style the two forms "stone-polygons" and "fissure-polygons" respectively. The stone-polygons are represented at one extreme by isolated stone-circles, while at the other they may become drawn out into a series of elongated mud-strips separated by strips of stone: these may be called "stone-bordered strips" (see p. 225). "Stone-bordered markings" may be used as a still more general term for this class of markings.

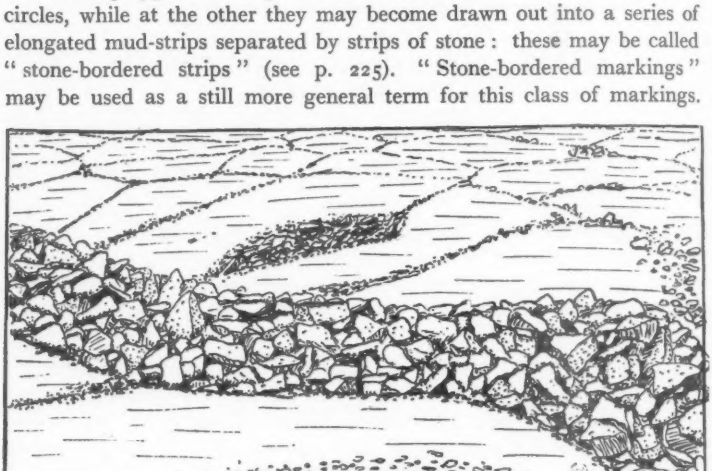


**Fig. 1.—Surface combining characters of fissure-polygons and stone-polygons: mud with a network of cracks, some with a few small stones; one rampart of large stones like border of stone-polygon. (Redrawn after Nansen, 'En Ferd til Spitsbergen,' p. 80.)**

"Polygonal markings" may be reserved as a non-committal term comprising both types of polygons. Högbom and also Nansen find that in certain localities transitional types occur (Fig. 1); but the two are usually sharply distinguishable.

**3. Stone-polygons.**—(*a*) We will begin by a general account of what is already known. These polygons constitute a very striking phenomenon. In suitable localities, whole areas, many acres in extent, are covered with a beautifully regular network of lines. On inspection, these lines are seen to be composed of stones, almost always up-ended, each line from 6 inches to perhaps 2 feet in width. The lines delimit regular areas, usually polygonal, which vary from 2 or 3 to 20 or 30 feet in diameter. The centres of the polygons are made of fine sticky mud, which remains

saturated with water much longer than most soils, and is almost always bare of vegetation. The stone borders may equally be bare, or they may be overgrown with plants. (For an account of the ecology of these polygons, the paper by Summerhayes and Elton (1923) should be consulted. This contains references to previous work.) The central mud is sharply delimited from the stones on the outside; and when, as is often the case, the polygon-marked area is considerable, the polygons broad and the stones composing their rims large, often deserving the title of boulders, the effect is very impressive.

These stone-polygons occur, in contradistinction to the fissure-polygons, chiefly on areas of hard rock which do not weather rapidly to a layer of fine materials, but are split up by frost into comparatively large blocks, and also on places such as the more level portions of moraines, which also consist of large stones, though these have been transported to the spot. The underlying stratum, according to Nansen (1921, p. 119), is always either solid rock or else subsoil ice, so that good drainage does not occur. They are never found on steep slopes, and apparently rarely (at least when well developed) on perfectly level ground.

Before going on to consider the mode of their genesis, it will be as well to discuss their structure a little more fully.

(1) *The Stone Borders.*—These, as all observers have noted, often show evidences of being compressed from both sides, the stones being usually up-ended. According to our own observation, sometimes the prevailing angle of the stones is such that they lean towards, at other times away from, the centre of the polygon; this would presumably depend on whether the lateral pressure exerted upon them by the mud areas was greater at the surface or some inches below it. The stones may project 6 inches to 1 foot or even more above the neighbouring mud-surface. The stones may be of very various sizes, even in one and the same polygon; further, the average size may vary from one area to another. The more resistant types of rock on the whole provide a larger average size of stones in the rings. Högbom records areas (in Norway) where the average weight was about 50 kg.

Sometimes the stones project well above the level of the centre, which is then a shallow depression filled with smaller *débris* (Nansen, pp. 114, 118, and Figs. 10 and 11, pp. 64–65). Usually, however, the centre is filled with the above-described mud, and if so always appears to be centrally convex. Finally, the mud may be particularly abundant relatively to the stones, and then seems to invade them, flowing over their edges and more or less concealing them (Högbom). In what may be described as very old polygons, on which a good growth of vegetation is to be found, the humus may mount up and practically hide the stone borders altogether, the stones then being only discoverable by digging down an inch or two. It is rare that any large stones are to be found in the mud area (but see later).

Various authors (*e.g.* Miethe, 1912, Meinardus, 1912, and Högbom, 1914) have excavated stone-polygons; they all report finding that the *definite* arrangement of materials continues downwards for some distance (between 1 and 2 feet); below this it becomes more and more indistinct. The lower layers contain more small stones and more very fine material than the upper. The arrangement of materials can usually be traced right down to the tjaele*; but, as Högbom observes, it is in many cases not certain whether the surface of the tjaele has reached its lowest point for the season. Meinardus once found the tjaele 1 to 1·5 m. below the surface; but Högbom has never dug down more than about half a metre in an area of stone-polygons before coming to the tjaele, and thinks Meinardus' case wholly exceptional. Only once has Högbom found evidence of an influence of the surface structure upon the tjaele. This was in Mimer Valley, Spitsbergen, in July, by which date the ground-ice was only 8 inches below the surface; here the stone borders rested in a shallow groove in the frozen material (but see below, p. 222). Miethe, on the occasion of his excavation, found the bordering stones dry, the centre saturated with water, and, he is careful to relate, no frozen ground at all: he did not excavate, though, below 28 inches.

(2) *Original Observations.*—The stone-polygons which we investigated were chiefly those inland from Richard Lagoon, near the north end of the east side of Prince Charles Foreland. Here they are extremely well developed; Nansen, with his wide experience of the Arctic, notes that he has never seen better examples than those in this locality.

In one area they were universal in the lower more or less level part, but absent on the steeper talus slope, although both were composed of the same rock. In both cases, also, there appeared to be solid rock of the same nature beneath—*i.e.* the polygons must have been produced *in situ* by changes in the surface of the rock; in some places a definite transition could be traced between typical polygons and blocks of stone being split off by frost from live rock. (See also Nansen, *loc. cit.*, p. 114, for similar observations.)

*Central Portions.*—The central portions here were always almost entirely of very fine wet mud, and convex in the centre. Sometimes a small "umbilicus" of smallish stones was to be seen right in the centre. In the majority of cases what we propose to call "secondary polygon-marks" were to be seen in the mud areas; these consisted of polygonal areas marked out by quite small stones mostly of 1 or 2 inches in diameter

* There is great confusion in the literature concerning the two types of formation known in German as Eisboden (=frozen soil or subsoil) and Bodeneis (=true ground-ice). Högbom has introduced the Swedish word *tjaele* for the former, and it will be used throughout this paper. Unfortunately, the distinction was not properly appreciated by us at the time of our voyage, or more detailed investigations of the tjaele below the polygons would have been made. (See especially Högbom, 1914; Holmsen, 1913; and Leffingwell, 1915 and 1919.)

(whereas the stones of the main borders were often 1 or 2 feet across), and apparently only near the surface, though this we cannot be sure is universal (see Plate 1). The number of such secondary areas seemed to depend mainly upon the size of the primary polygon. In some polygons these secondary areas were further subdivided into tertiary polygon marks, the border-lines of which consisted of very small stones indeed.

Secondary areas may also be delimited by each having its own convexity. Usually there is one central convexity surrounded by a single ring of other convex areas. In some cases where the secondary areas were well delimited by the borders of small stones, their convexity was not marked, or appeared wholly absent.

*Borders of Mud Areas.*—A very characteristic appearance in many polygons, but one not mentioned by Högbom, is that of ***mud folds*** (Fig. 2B). Just where the mud meets the stone border there are to be seen small ridges of rather more solid mud, rising perhaps a couple of

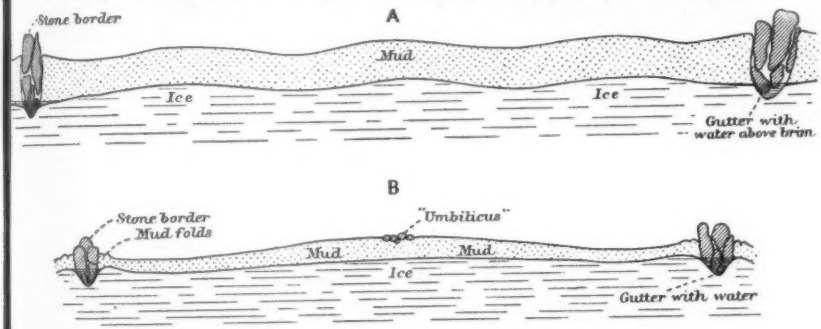



**Fig. 2.—Diagrammatic sections of two stone-polygons excavated on Prince Charles Foreland early in the season (first week in July 1921). The domes are slightly exaggerated in the upper figure.**

inches above the neighbouring mud, and running parallel with the stone borders. The number of these folds at any one place varies from one up to three or four. They are colonized by plants before the rest of the mud area. These folds afford the most conclusive evidence of the existence of a lateral thrust at the edges of the mud area, for it is impossible to conceive of their arising in any other way than by sideways pressure. Their general appearance reminds one of the folds caused by pressing up the skin of an animal's back towards its head.

*Sections of Polygons.*—We cut sections of several polygons, and obtained the following results (see Fig. 2, A and B). At the time when the observations were made (first week in July), the whole area had been covered by snow less than a week back. Accordingly the tjaele ice was still very close to the surface.* In one mud area it reached to within

* As noted above, we did not pay sufficient attention to the frozen materials underlying the polygons; since for our purpose at the time it was sufficient to discover a

about 5 inches of the surface, in another to about 11 inches. In every case the gutter described above in the tjaele by Högbom as existing under the stone border in his July-excavated polygons was seen; its depth varied between about 3 and 5 inches. The contour of the surface of the tjaele, however, was related to that of the surface markings in other ways as well. In three cases it was found that beneath each mud-convexity there existed a slightly less-marked convexity of the ice material, whereas in one other case to the convexity of the mud there corresponded a *concavity* of the icy layer below. This last polygon was small and moderately invaded by plants, whereas the others were large, with practically no vegetation even on the stone borders. In the largest of all (Fig. 2, A), which was an oval of about 18 and 28 feet diameters, there was a central secondary mud dome surrounded by nine other secondary domes. The tjaele-domes below these peripheral mud-convexities sloped gradually away to the sides until they reached the edge of the ice gutter, which contained water. The water more than filled the gutter, standing about 1 inch above the level of the inner edge of the gutter. The ice gutters form an inter-connected system of channels through which water can slowly flow off; whereas the mud is so fine that it remains saturated, or almost so, with water, although above the water-level in the gutters.

In the other two large polygons there was only one mud and one tjaele dome; and instead of a uniform slope down to the edge of the gutter, there was a marked ridge of ice rising up to form a rim on the inner side of the stone border (Fig. 2, B).

Contrary to what Högbom says (*loc. cit.*, p. 313), the surface of the tjaele was quite sharply delimited, and was not particularly irregular.

It may be stated here that Högbom's view appears to be correct, viz. that the conformation of the surface of the tjaele is purely secondary, being consequent upon, and not antecedent to, the surface arrangement, although it is difficult to understand why the mud-convexity should in some cases cover an ice-convexity, at others an ice-depression. Possibly the fact that the margins of the latter polygons were more or less overgrown by plants may have caused the tjaele to melt less rapidly under them than under the barer centre.

**4. Fissure-polygons.**—It appears definitely that there are two quite distinct types of these, which in a classification based upon origins should

frozen layer quite impermeable to water, and we were not aware of the interest attaching to the problems of ground-ice *per se*. However, our recollection is clear that the material immediately below the mud was mainly ice, not mainly soil. In view of the theories of Holmsen (1913) and of Leffingwell (1919), it would be important to discover if the frozen layer under the stone polygons was composed wholly or mainly of pure ice or of ice with soil inclusions, or only of wet soil frozen hard. Since Högbom (1914) expressly refers to it as *tjaele*, we shall also do so, although emphasizing the need of further work.

1. Larger stone-polygons, Prince Charles Foreland, early July 1921: secondary markings within the larger areas, and large stone block in the stone border on right.

*Phot. C. S. Elton.*

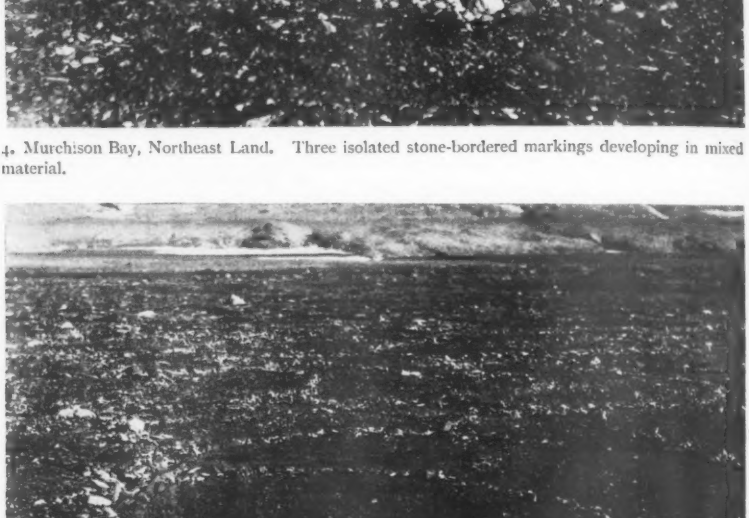
2. Fissure-polygons, Klaas Billen Bay, on nearly level surface halfway between Bruce City and mountains; very dry (August); no stones: convex secondary areas.

*Phot. J. Walton.*

3. Small stone-polygons, Prince Charles Foreland, early July 1921: snow lying in central areas.

*Phot. C. S. Elton.*

4. Murchison Bay, Northeast Land. Three isolated stone-bordered markings developing in mixed material.



5. Murchison Bay, Northeast Land. Old stone-polygons nearly reduced to mud.

6. South Waigat Islands. Stone-bordered polygons.

*Photographs by J. D. Brown.*

be sharply separated. These are (*a*) the tundra polygons, and (*b*) the mud-flat polygons.

(*a*) *Tundra Polygons.*—Comparatively little attention has been paid to these. Leffingwell (1915 and 1919), in the very severe climate of N. Alaska, describes a system of very large polygons averaging 15 m. and ranging from 12–20 m. across. These arise in the first instance by cracking due to contraction in the cold of winter. Loud reports due to this cause are heard throughout the winter in Alaska. The cracks fill with water, which freezes, forming an ice-wedge in the crack. The ice-wedges grow year by year, and give rise to various types of large polygonal markings. The largest wedges reached a diameter at their upper end of 3 m., with an estimated depth of 6 to 9 m.

The whole tundra is gradually being elevated owing to the growth of these ice-wedges, which constitute the only true ground-ice of the region.

An apparently similar type of large tundra polygon is described and figured by Holmsen (1913, *e.g.* Pl. 3, Fig. 1) from Coles Bay, Spitsbergen. They appear to be found in flat areas of damp tundra, and would naturally arise most readily where the temperature was lowest.

Leffingwell emphasizes the fact that one is apt to mistake this polygonal system of ice-wedges for a continuous sheet of ground-ice. However, the observations of Holmsen certainly seem to point to such horizontal sheets occurring at least in some spots. Again, more work in various arctic climates is needed. Whichever view is adopted, the interesting fact emerges that in flat wet arctic areas true ground-ice is formed, and accumulates year by year, so that the ground-level is raised by this means (Leffingwell, 1915; Holmsen, 1913, p. 138).

(*b*) *Mud-flat Polygons.*—These are the fissure polygons usually figured and discussed. They occur in mud areas which are liable to dry up at some period of the year, and are of a considerably less average diameter than the tundra polygons. They too need not detain us long. It is clear that they are not *merely* desiccation products, as was for long supposed, since (1) they are very often extremely damp, especially in the centre, and may be actually covered with water; (2) they are more regular than anything produced in other regions by drying; and (3) are characteristic of the Arctic, having almost the same distribution as the stone-polygons.

They occur typically in muddy or clayey soils in which the particles are small and fairly uniform. They appear to originate when little or no vegetation has covered the soil. Colonization by plants takes place only later, after their appearance. They appear to be invariably convex in the centre (another distinction from the fields produced by drying, which are usually concave, with small but sharply upturned rims). The cracks which separate them may be sharply open, or filled almost to the top with soil, or the margins of the fields may be only marked by a differ-

ence in vegetation. Vegetation always grows first, and best, round the edges, the centre being usually too saturated with moisture. They are usually smaller than the stone-polygons, averaging 2 to 10 dm. in diameter; often, however, the smaller polygons form part of larger polygonal areas whose borders are marked either by a better development of the splits between the component small polygons, or by actual continuous splits of their own (Högbom, Fig. 19). These large fissure-polygons have been seen to reach a diameter of 15 or 20 m. in Spitsbergen (Högbom, 1914, p. 326; and Wulff, 1903), and over 30 m. in Siberia (Middendorf, 1867). We may speak of the larger and smaller areas as *primary* and *secondary fissure-polygons* respectively.

They occur especially in the muddy alluvial and delta areas, but are to be found also in humus and peat, and in material derived from subjacent rock by weathering *in situ*. This last material is often not uniform, and consequently it is in such situations that the transitional forms between fissure-polygons and stone-polygons are to be found (Högbom, *loc. cit.*, p. 325). A good example of such a transitional form is given by Nansen, and reproduced here as Fig. 1.

In some cases also systems of small fissure-polygons have been observed within stone-polygons, the occurrence of the former in this case being no doubt secondary and due largely to desiccation.

Two chief explanations have been given of the actual origin of fissure-polygons: (1) that it is by repeated alternation of freezing and thawing, the expansion of freezing causing a number of convexities to be thrust up, while the contraction of thawing does not succeed, in any one area, in flattening out this convexity again, so that fissures are the result; (2) that it is by drying, desiccation producing shrinkage and consequent cracks. It seems clear that even if this latter explanation holds good for their first origin, the alternation of freezing and thawing which will occur later must help to determine their ultimate form. Such appearances as that reproduced in Fig. 1 are hard to understand unless comminution has been at work in the area, the rampart of stones in the foreground of the figure having been less comminuted than the areas now reduced to mud.

Högbom mentions that he has found hard-frozen fissure-areas in which the splits had not closed up. He does not draw any conclusions from this; but it would seem to be legitimate to suppose, with Nansen (1921, p. 110), that rain or flood water—accumulating in the cracks after thawing has occurred, and then freezing solid when the temperature falls—would prevent the closure of the fissures, and thus lead to an accentuation of the central convexity, since ice is now occupying some of the space originally taken up by soil. The process would thus be automatically reinforced as time went on.

Wulff (1902, 1903), on the other hand, maintains very strongly that these fissure-polygons are due *solely* to drying. His observations were

made on the great mud-flats in Wijde Bay, Spitsbergen. His most important contribution to the subject is his tracing of the fissure-polygon systems throughout the season. He finds that in spring there may be no fissures in the mud at all, but that they appear during the summer, when the mud is so dry that footsteps leave no trace. Some of the larger polygons may be up to 20 metres a side, containing secondary polygons of the usual small size.

However, he does not fully discuss the possibilities of repeated frost action, which, as we have pointed out, must occur; he merely dismisses it with the statement that "freezing certainly helps the mutual cohesion of particles."

In this connection it may be worth putting on record some observations of a colleague of one of us, Dr. W. R. Smellie, who has been in Mesopotamia for some time. Large areas of cracked mud are to be seen in this country. Sometimes, as in the Arctic, there is a double system of polygons—larger polygons estimated at 5–10 feet across, delimited by large cracks, and these subdivided into smaller polygons perhaps 6 to 12 inches in diameter. The polygonal areas are always centrally *concave*, and the concave top layer is usually hard-dried and separated from the mud beneath. Dr. Smellie is inclined to think that the fissures are not continued deep into the mud, but end at or close to the top of the moist layer which is protected by the concave "saucers" of baked mud; if so, this would be another difference between them and the Arctic polygons. The jointing probably comes first, the concavity being a subsequent effect of differential drying as between upper and lower surfaces. At one place convex polygons were seen, but here the effect was certainly due to weathering, as in the similar case in the Arctic (see below, p. 216); such convex polygons were not very regular, and had broad channels between.

What is not clear from any of the work that has been done is whether the cracks are from the outset the product of frost action (thawing-contraction), or whether drying-cracks originating in summer are the centres for the start of the phenomenon. It should be possible to solve this experimentally by preparing a uniform layer of mud near a camp in Spitsbergen, keeping it moist against desiccation, and noting whether fissure-polygons are formed in it through repeated frost action alone.

It is an interesting and possibly significant fact that the regularity of the fissures, and the way in which three fissures constantly meet at a single point to form five- and six-sided figures, bear a striking resemblance to the jointing of basaltic rocks. Although it was at one time held that the hexagonal prisms in the latter were due to the squeezing together of originally circular columns owing to the expansion of the mass—an inference geometrically incorrect since this process would give rise to rhombic dodecahedra more or less regular—it can now be shown that the polygonal structures assumed by basalt and other basic rocks on con-

solidation are many and have arisen from the cooling and contracting of the mass and its varying degree of homogeneity.

A remarkable secondary condition of the fissure-polygons is sometimes met with, due to weathering. Where the polygon area is liable to flooding, the water will flow off along the cracks, and will consequently erode their sides; as a result, whole tracts composed of the remains of the central areas in the form of small rounded mounds, separated by cracks now enlarged to miniature valleys as broad as the mounds, are to be found. This not uncommon but interesting condition is well figured by Högbom (p. 321).

Hindle (1917) holds that under *saline* conditions and a certain correct tenacity of the mud, the borders of polygons are curved downwards: this is from experimental evidence.

Mr. Elton this summer (1923) noted on the shores of Reindeer Peninsula, Liefde Bay, an area which may owe its characteristics to this cause. It was an extensive mud-flat just above normal high-water mark, but probably submerged from time to time by salt water. That it was strongly saline was evidenced by its halophytic vegetation. A photograph of it is in the R.G.S. collection. Its chief characteristic is its subdivision into very small fissure polygons averaging 8 to 20 cm. in diameter. These were strongly convex; they had a few salt-loving lichens growing upon them. The most remarkable feature from our point of view is that these small polygons are not grouped into larger polygons. In other words, the primary fissure-polygons are absent—the large areas which we suppose to owe their origin largely to repeated frost-action. No detailed explanation can at present be offered for this phenomenon.

Plate 2, from a photo by Mr. J. Walton, shows convex secondary areas, but not nearly so much eroded as those in Högbom's figure. It is doubtful, in view of the position of the fissure-polygons here figured, if erosion can have accounted entirely for their shape. The area was not saline, since Dryas was growing there. The photograph clearly shows the plant-grown main fissures bounding bare central areas in turn divided by secondary fissures.

5. **Arcuate Markings.**—A third and we believe new type of marking was noted by one of us (N.E.O.) at considerable heights (3500 to 4000 feet) at the head of the Oxford Glacier, in Garwood Land. Here, on a surface of bare rock, containing numerous fine cracks and jointings, were numerous marks in the form of arcs of circles. In these arcuate markings the jointing and fissuring of the rock was more severe, and ran parallel with the curve of the arcs. When traced downwards by excavation, the fissured arcs were found to grade off into live rock. The radius of the arcs averaged about 20 feet or less.

This form of marking was only seen in shales, which, as stated, contained numerous fine cracks. It was not noted on adjacent areas of dolomites. Its occurrence was on the broad, flat eroded top of a mountain

altogether devoid of slope, and the stone arcs were not raised above the general surface (*vide* Fig. 3).

6. **Theoretical.**—(*a*) The third type of marking will not detain us. It is mentioned here chiefly to attract the attention of other travellers in Arctic or high Alpine regions to what appears to be an undescribed phenomenon. Since these markings were never seen in the form of complete circles or polygons, it seems clear that they have no close connection with either the true fissure or the stone polygons. This is also borne out by the fact that the central portions of these markings were never muddy, but, on the contrary, were less broken up than the borders.

Högbom (*op. cit.*, p. 275) describes the way in which isolated portions

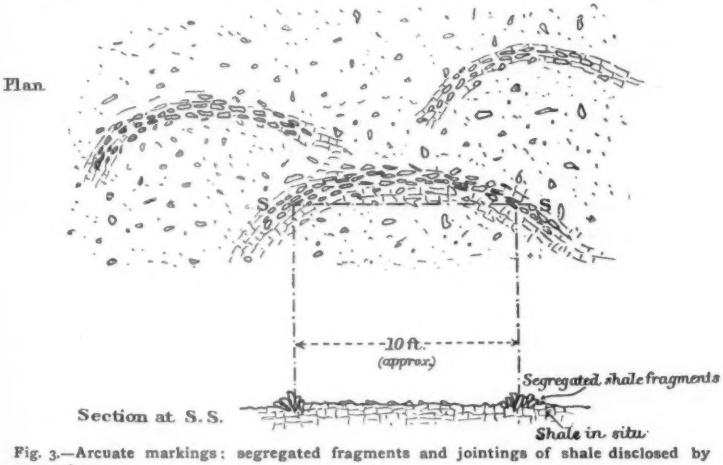



Fig. 3.—Arcuate markings: segregated fragments and jointings of shale disclosed by excavation.

of a solid rock surface covered with vegetation may be upheaved several feet by long-continued frost action. If an exposed surface of bare rock is much fissured with cracks, it is conceivable that the alternate contraction and expansion of repeated frost-action * may cause it to give way at certain spots, and that the distance between these points of "give" would be partly dependent upon the nature of the rock, *i.e.* that the arcs would tend to bound areas of the same general order of size—as is found as a matter of fact with the stone-polygons, whose size is roughly constant over a given area.

(*b*) For the mud-flat fissure-polygons, it seems clear that cracks

* Högbom uses the term "regelation" to denote the often-repeated alternation of freezing and thawing so characteristic of the polar summer. However, the word has a different significance in English; we have therefore fallen back on "repeated frost-action." It would be well to have a single term for this.

arise in damp muddy soil of uniform consistency, in the first instance *either* by drying *or* by contraction at thawing, and that alternate freezing and thawing gradually bring about the regular polygonal form. Once cracks have arisen there is differential water-content, the parts near the cracks being better drained; further, repeated frost-action in the wet centres leads to even finer division of the particles of stone there, and the smallness of the particles enables them to hold more water by capillarity. This reinforces the process, as does the filling of the cracks with water and their freezing solid. This self-reinforcement of physiographical processes is not uncommon. The best-known example is of course the formation of efficient drainage systems from the mere run-off of water. Self-reinforcement also characterizes the growth of the tundra fissure-polygons once these have been originated by cooling contraction.

(*c*) The tundra polygons have already been sufficiently discussed.

(*d*) The true stone-polygons remain, as they have always done, the most difficult problem.

(i) Previous theories. It is unnecessary now to consider any of the theories which regard them as due to running water, or to drying, or to a mere swelling up of pre-existing muddy areas among stones, as they have now only an historical interest.

The observations of Trevor Battye (1921) on stranded ice-flows are interesting in themselves, but cannot well have a bearing upon the majority of cases, in which stone-polygons are formed inland.

Since Högbom's work it has become evident that frequent alternation of freezing and thawing, such as occurs in summer in the Arctic, is the chief agent at work in their production. Nansen points out that the frequent *isolated* occurrence of stone-polygons as stone-circles is evidence against their development from fissure-polygons.

Högbom himself believes that they arise in regions where the soil is composed of mixed material of various sizes, and that the frost-action in the long run sorts these materials, pushing the coarser to the sides, leaving the finer in the centre. Any area, according to him, which happens to contain a little more fine material will imbibe and retain more water. When freezing occurs this will expand more than the rest, and will push out the material at its edges centrifugally. When thawing and consequent contraction take place, the fine material will be sucked back again by adhesion, while the stones will be left behind. This process, repeated at each of the innumerable acts of refreezing, will end by producing the typical differential arrangement. This we may describe as the explanation by *differential movement* and consequent *sorting of pre-existing materials*. The above ideas as to the mechanism of sorting are held also by Douvillé (1916).

Nansen, on the other hand (*op. cit.*, p. 112), is dissatisfied with Högbom's explanation, largely for the reasons (*a*) that he finds examples of stone-polygons arising on live rock, (*b*) that where mixed material is

to be found in Spitsbergen, polygons are often not to be seen. He believes that they arise as follows. The surface is not completely level; and snow will lie longer in any depression. Round the edges of these snow patches, which of course diminish during summer, the ground will be wetter than beyond their confines; therefore the splitting action of frost, recurring throughout the summer, will be exerted more in the snow-patch areas (Nivation effect, cf. Matthes, 1900). This will lead to differential weathering, the wet material in the hollows being comminuted faster than the drier material round the edges. Once comminution has got to a certain pitch, the fine material will retain water more readily, the differential rate of comminution will be accelerated, and the lateral thrust postulated by Högbom will begin to be exerted.* This may be styled the theory of *differential comminution of originally uniform material.*

(ii) Our own view is that against both these theories, as actually advanced in isolation and mutual opposition, certain facts may be urged. The comparative regularity of size of the stone-polygons in any one area is not explained by either theory, nor are the secondary and tertiary markings taken into account.

Högbom's hypothesis does not explain the almost complete absence of rock fragments intermediate in size between the large stones of the borders and the extremely fine particles composing the centre. Nansen in his theoretical discussion seems to overlook the fact that the centre of *well-developed* polygons with mud areas are always convex, not concave, although he mentions it as a fact elsewhere; to this, however, he might well respond that the central convexity may be secondary, and late in its appearance. Nansen also appears to underestimate the importance of the *lateral* pressure upon the stone borders of the marks, while Högbom certainly underestimates the importance of differential comminution.

It appears that a combination and extension of the two theories will lead to the most satisfactory explanation. In favour of Nansen it is to be said that he has described and figured slight depressions in the weathering surface of live rock, which contain smaller materials than their borders (Fig. 4), and that snow often does lie longest in the central areas (Plate 3);

* Nansen thus admits the existence of this outward thrust, but only after a certain stage in the process has been reached. He also notes that the mud centres will often overwhelm the stone borders. Further, he considers that during thawing the stones, being better conductors of heat, melt the contiguous mud-mush; this allows water to percolate downwards, the stone not sinking itself as it is supported by a little column of frozen mush (or another stone); on refreezing the stones conduct the temperature-drop downwards relatively quicker than the mud-mush, and the percolated water freezes beneath the stones and tends to push them upwards. This action, he claims, explains the constant occurrence of collections of stones on the surface of mud areas (*vide* Fig. 4). But he considers where polygon-marks have mud-cracks within them the upward action on the stones around is hindered. These two processes would determine (*a*) the polygon arrangement in so far as lateral pressure is involved in its genesis, and (*b*) the occurrence of stones on the surface and their up-ending.

and see Allix, 1923, where interesting figures are given of just-forming as well as of well-formed but small stone-polygons in the French Alps.

We may perhaps think of the process as follows : The surface of rock in the Arctic is rapidly cracked by frost-action and broken up into larger and smaller stones. Wherever differential comminution occurs, it will be a *self-reinforcing process*, since more cracks and more surfaces mean more water, which in its turn means more violent frost-action per unit volume of rock. It may start *in situ* in live rock, or in collections of stones (*e.g.* moraines) transported to the spot.* Differential comminution may be started by irregularities of resistance in the rock, by running water washing fine materials together into collections which will then retain more water, or by moisture round and under snow-patches. Once comminution has reached a certain degree, the processes described by Högbom will begin, viz. considerable lateral thrust on freezing, and out-

Fig. 4.—Isolated stone-ring with mud in centre and broad circular rampart of large stones, surrounded by small stones without arrangement. (Redrawn after Nansen, *loc. cit.*, p. 65.)

ward " creep " of stones due to their being thrust out with the rest on freezing, but not being drawn back with the more adhesive fine material on thawing and contraction.

A further point, not taken into account by either author, is this. When the rock surface has been considerably broken up, the regions of large stones will conduct heat better than those of fine material. This will lead to the formation of gutters in the subsoil ice, as above described, at least during the early summer, when the ice is near the surface. Once these gutters form a connected network, they will provide channels through which all water running off the area must flow. The capillarity of the mud-areas is so great, as can easily be observed on excavation, that

* C. S. Wright (p. 132), from observations in the Antarctic, maintains that "polygons are best developed in the angular morainic material which outlines a former glacier-covered bed." He finds it difficult, however, to give an adequate explanation of the mechanism involved.

run-off through them will be negligible. This will mean that all fine material in the borders will be washed down into the gutters and carried away, thus leaving the stones free of mud, allowing their tops to dry still further, and again reinforcing the processes already in operation. The lower ends of the stones will be wet and so much more subject to repeated frost-action and splitting than the upper; thus larger stones should be found at the upper part of the borders, smaller ones deeper down, as is actually realized in fact.*

There remains the question of the uniformity of size of the polygons; and the question of the secondary and tertiary markings.

We can best think of the polygon-marks as one stage in a series of processes leading to the comminution of the surface of live rock or areas of transported blocks, in certain flattish Arctic regions. It is, further, a comparatively long-enduring stage. In an earlier stage of this process, when the arrangement of materials has just begun to be clear, no doubt the markings are smaller and more irregular than later. General comminution is still continuing, although faster in the wetter areas of fine material than elsewhere. It will be relatively retarded wherever ice-gutters are formed and the moisture-retaining fine material is carried away, leaving the large stones dry. In the early stages (Fig. 5, A) there will of course be relatively more coarse material than later, and of more mixed size, so that the formation of ice-gutters will not take place until the later stage when the polygonal arrangement is well marked. As Högbom himself has shown (and cf. footnote, p. 219, and Nansen, *op. cit.*, p. 117), in mixed material in the Arctic large stones tend to come to the surface; further, repeated frost-action will occur more frequently in the deeper layers just above the ground-ice than close to the surface.

As a result of this, the moderate-sized material in the comparatively small irregular areas to be found in early stages of polygon-formation will mostly be comminuted, *especially in the deeper layers*. Once this has happened, however, the fine material will become continuous between the deeper layers of various smaller areas (Fig. 5, B). Where a considerable amount of rock or boulder remains uncomminuted there will be no fine materials, so that the areas of continuous fine material will be separated from each other, although each such area is formed by the fusion of several originally separate centres of comminution. Once this fusion has occurred, each of these larger areas can act as a unit in the volume changes of repeated frost-action, and so exert more lateral pressure; and the centrifugal progress of the larger as yet uncomminuted blocks will therefore now be accelerated. Only when a comparatively large number

* Allix (1923) states that in the centres of incipient polygons in the French Alps, a column of frozen snow or ice 20–30 cm. diameter extends downward for ¾ to 1 m. By ice he probably means very wet soil frozen. The expansion of this area on freezing would cause considerable lateral pressure. This is in good accordance with our general views.

of large-sized stones have been squeezed together into a border will their presence cause a well-developed ice-gutter to arise as indicated above (Fig. 5, c). Once this has arisen, however, as already explained, it will tend to retard comminution still more in the areas above it. Thus the stages previous to the formation of ice-gutters are relatively unstable and imply rapid comminution over the whole area; whereas subsequent stages are relatively stable, characterized by little comminution in the stone borders, and by comminution reaching a limit in the central areas. The relative stability of " ramparts " of large stones kept dry by drainage is illustrated in Fig. 1, where a serpentine stone rampart is seen to have maintained itself in the midst of an area otherwise almost wholly reduced to fine mud.

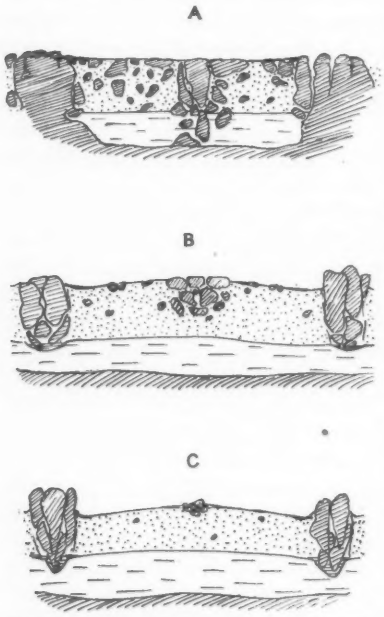



Fig. 5.—Probable origin of stone-polygons. Oblique shading represents rock and stones: horizontal lines ground-ice or frozen soil; mud is dotted.

The processes leading up to the establishment of ice-gutters will take a certain amount of time, according to the nature of the rock, the amount of repeated frost-action, etc. Further, the average size of the polygons in different areas will also depend on differences in these circumstances.

Of course comminution will still proceed even after the gutter stage, so that the stone borders will tend to get smaller and smaller and eventually to disappear into mud. However, before this happens, the inner edge of the stone border seems often to become colonized by plants, which gradually spread on to the mud-centre. This then becomes somewhat drier, and the whole area becomes humus covered, with much slower rates of weathering and comminution. It is not clear what brings about that degree of drying in the central areas which permits them to be colonized by plants. Whether the colonization by plants occurs or no appears to depend on the nature of the situation.

The early areas of stone undermined by comminution will leave stones near the surface. These will become subject to differential movement, so that regular secondary polygons will arise from them. Since, however, they do not reach down to the ice, there will be no ice-gutters beneath

them, they will remain wet, and will be rapidly comminuted ; this explains the great difference in size between the stones of the main and the secondary or tertiary stone borders. It is not clear how far the secondary polygons represent only early stages in the formation of polygonal areas, and how far they can be thought of as remains of well-formed true stone-polygons afterwards undermined by deep comminution. The " umbilicus " of small stones occasionally seen in the centre no doubt represents the junction of several secondary polygons.

After the stable phase is reached, denudation will of course continue, the water channels below the stones continually removing fine particles. It is clear that it will be greatest close to the ice-gutters, and that therefore the central portions of the mud-areas will become convex. It is very difficult to account for this convexity as a result of the expansion due to freezing alone. If water-erosion accounts for the mud-domes, it is clear that the presence of domes in secondary polygons indicates that these were originally well-developed stone-polygons with drainage channels under their borders which have subsequently become filled up.

Thus the stone-polygons, it appears, always represent part of a temporary phase in the surface of Arctic lands. If the selfsame processes which lead in the first instance to the establishment of stone-polygons are continued long enough, they will finally cause their disappearance, by converting them into uniform soil. With further knowledge, it might conceivably be possible to obtain some idea of the time a country has emerged from glacial conditions by the condition of its stone-polygons. Mr. G. Slater, of the Imperial College of Science and Technology, informs us that in the Boulder Clays of East Anglia there occur groupings of stones vertically disposed, and although the investigation of these has not yet advanced sufficiently far for complete determination, yet their occurrence in glacial beds is somewhat suggestive to us of the phenomenon of stone-polygons. Investigation of these stone groupings is at present being undertaken by Mr. Slater.

Large boulders which for some reason or other have not been easily split up are occasionally to be found. These are rarely isolated in the centres of polygons, but more usually touch the stone border. It is clear that greater resistance of any area of rock will help to determine the limits of the polygons, as well as the accidental depressions postulated by Nansen ; but it is not clear what relative importance to attach to differential movement and to differential comminution in the attainment of the polygonal pattern. The work of Eakin (1916), if confirmed, would indicate that in certain types of polygonal soils there is very considerable movement of parts relative to each other, although it is difficult to believe that the continual " circulation " of large stones postulated by him (up through the centre, down at the sides) can actually occur.

One further point remains to be mentioned, and that is the upward force exerted in certain types of frozen soils, which may throw up earth

or boulders in curious ways, and probably plays some part in the genesis of stone-polygons.

In subarctic peat moors (Högbom, 1914, p. 306) hummocks may be found reaching 7 m. above the general surface: one winter's growth in height is 10–35 cm.! The action is due to repeated freezing below. In Spitsbergen (Sassen Bay, Högbom, 1914, Fig. 2, p. 275) there occur localized elevations of large boulders out of a layer of diabase, the blocks being raised several feet above the surface, and giving a most remarkable appearance to the landscape.

Small elevations of the surface of marshes hard frozen in winter are described by Brandt (1916) from the Pripet–Dnieper region. They often start as small mounds of fresh earth. Similar mounds of fresh material were noticed by Mr. Elton this summer on Reindeer Peninsula, Liefde Bay, Spitsbergen. The country here is rolling, and consists of schistose sandstone. Here and there isolated convex areas 1–1½ m. in diameter and perhaps ¼–½ m. high were seen, so fresh as to be almost or quite uncolonized by plants. They showed no secondary drying-cracks. Somewhat similar but smaller and more irregular areas of fresh soil were seen along strikes and outcrops of rock. See also Doss (*Neues Jahrbuch*, 1913 and 1914, quoted by Högbom, 1914, p. 307).

Much light could be thrown on the problems of polygonal markings by simple experimentation in the Arctic by workers who remain at least for several months, or preferably return to the same region for a series of years. (1) Excavations at different times during the summer in adjacent polygons would show how rapidly the ground-ice retreated from the surface, and whether the ice-gutters and other surface features of the ice were retained throughout the season. (2) Mingling stones of various sizes in the mud and noting any change of position would show the *rôle* of differential transport of material, and would decide whether the size of the blocks made any difference to their rate of movement. (3) Digging up sets of adjacent polygons and replacing them (*a*) with a mixture of their stone and mud content; (*b*) with fine material only; (*c*) with stones only; (*d*) with a more uniformly graded mixed material, would throw much light on the processes at work. (4) Inserting small stakes or steel rods vertically to different depths in the mud across the breadth of numerous polygons and noting their movements of place and inclination would give information as to the strength of the lateral pressure and its relative importance at various depths (5) Inserting objects at known depths below the surface in regions where ground-ice occurs would enable us to gain much information as to the annual growth of ground-ice and its formation in general.

7. It remains to mention the chief modifications of the stone-polygons due to "solifluction" (or soil-flow) and other causes; but this can be done very briefly, since our observations and classifications agree closely with those of Högbom. (A) *Stone circles*. Here and there, markings

obviously similar to stone-polygons occur, but in isolation. This is of importance, as it indicates that action from single centres is at work in the formation of stone-markings (see Fig. 4). (B) *Stone semicircles.* In some areas, always on slopes, especially on those with fair gradient and considerable vegetation, polygons are replaced by semicircular areas, flat above and ending towards the slope in a steep rampart. The rampart is stony and more richly overgrown, the centre of the flat portion more muddy (typical *Steinguirlanden* of Högbom). (C) *Elongate polygons.* On parts of stone-polygon areas with somewhat more slope than the rest, the polygons are often elongated in the direction of the slope, sometimes with the upper end drawn out into a narrow neck. Solifluction is obviously at work in these, being facilitated no doubt by the solid frozen subsoil. In some conditions of slope and soil, the lower border becomes strongest and the type passes over to the semicircles above described; in other conditions, apparently when solifluction is more active, the lateral stone-borders are the more pronounced, the upper and lower borders tend to disappear, and we have a transition to the next type. (D) *Stone-bordered strips.* ("Soil-strips," "Steinstreifen," "Streifenboden," "Striate land," etc.) These are also found only on slopes. Here a number of rows of stones are to be seen parallel with the slope, with softer material between. The whole is obviously moving downwards by solifluction. These are found where drainage is poor, vegetation less, and downward movement more rapid. The distance between the bands of stone is similar to the average diameters of stone-polygons. This type is extremely interesting. Högbom's researches on solifluction make it clear that on well-developed solifluctional slopes of mixed material, the different-sized stones move downwards at different rates, and any stones again at a different rate from the fine particles. This would prevent the *transverse* bands of stone from retaining a constant position relative to the mud areas. (The preservation of the transverse bands would only be possible on better-drained slopes in which vegetation held the stones together, so creating a rampart which moved downwards as a whole, as in the stone semicircles.) The stones of the transverse bands thus get distributed among the mud, are not kept dry through ice-gutters beneath them, and consequently are rapidly comminuted. On the other hand, although the lateral stone-bands may move at a different rate from the mud-strips, they can retain their individuality. This again emphasizes the importance of the large collections of stones in borders if a stable condition is to be reached.

Thus frost-effects are responsible for all the types of stone-bordered surface markings seen in Spitsbergen, operating (*a*) by differential comminution, (*b*) by lateral pressure often accompanied by differential transport, and (*c*) by solifluction. The reason that they are not found more widely in high Alpine regions appears to be the absence there of comparatively level ground. Högbom (p. 375) quotes examples from

the Engadine (Tarnuzzer, 1911) and from the Andes, and Allix (1923) finds small stone-polygons in the French Alps. They are common, however, in the higher parts of the Scandinavian Mountains. Douvillé (1916) cites examples in Iceland, Greenland, Urals, north coast of Siberia, Antarctic,* and Falkland Islands. Schimper (Pflanzengeographie, 1898) saw well-developed "polygonboden," and arrangement of vegetation with respect to the polygons, in the high plateaux of the Pamirs; and Wulff (1902, 1903) cites fissure-polygons seen by Wetzstein in Syria. Douvillé maintains that they are not found in Norway below 1400 metres above the sea, nor more than 100 metres below the snowline. It is important to notice that their presence depends mainly on the meteorological conditions, much less upon the kind of rock. Mr. Elton, however, informs me that he never saw stone-polygons in Spitsbergen on granitoid metamorphic or dolerite areas, except in one place where a dolerite area bordered a raised beach. Apparently the mode of weathering of dolerite does not produce the conditions necessary for stone-polygons, possibly because it is always very dry.

In conclusion, we would like to express our thanks to other members of the Expedition for help in the field and in subsequent discussion, particularly to Mr. C. S. Elton and Prof. A. M. Carr-Saunders.

*Postscript* (J. S. H.).—Since the above was written, the Merton College Expedition has returned from Spitsbergen, after a successful voyage to more easterly regions of the archipelago (north coast and Hinlopen Strait) than those visited by us in 1921, and has brought back information and photographs of considerable interest concerning polygonal markings. We have to thank Mr. C. S. Elton for permission to use his facts, and Mr. J. D. Brown for leave to reproduce his photographs.

1. In regard to weathering in general, Mr. Elton had the opportunity to make the interesting observation that on the shores of Hinlopen Strait and to the east of it (south-east coast of N.E. Land) no unfragmented sedimentary rock was to be seen at the surface, the only rocks of which solid outcrops or even large boulders were to be found being dolerite. This is not the case on the west and north coasts and fjords of the main island. The difference is of course to be correlated with the increasing severity of the climate as one passes from west to east, and consequently greater violence of frost-weathering.

2. Mr. Elton took detailed measurements of another stone-polygon, on 2 August 1923, on the west coast of Hinlopen Strait, near the South Waigat Islands. Here too, as in the previously reported cases (p. 211), tjaele was close to the surface, and its upper limit was not irregular. There was a single mud-dome, but an underlying ice-concavity, as in the case reported on p. 212. The stone border consisted of medium-sized stones, not up-ended, but with a narrow inner strip of up-ended fragments of shale; the large centre was all mud. His actual figures were as follows (all are in cm. Those not in brackets refer to depth from surface to subsoil ice; those in brackets to distances between spots at which depths were taken. The measurements run across the longer main diameter of the oval marking): Centre of stone

* As mentioned above, Wright (p. 132) also cites occurrences in Antarctica.

border: 5·1–(14) mud just within stone border: 6·5–(32): 6·1–(20) centre of mud area: 6·5–(32): 5·8–(21) centre of stone border: no depth taken.

3. Plate 4 shows, better than any published figure of which we are aware, the formation of the *isolated* stone-bordered markings, which naturally take the form of rings, to which allusion has already been made (p. 224). These were seen in Murchison Bay, in mixed rock fragments derived from a raised beach or sea-floor. The three examples shown all have mud centres. It thus appears necessary, at least in a substrate of this nature, to have a considerable degree of moisture and comminution in the centre before sufficient lateral thrust can be generated to cause the formation of a stone rampart. The elevation of the stone rampart above the general surface, both inside and out, is well shown.

4. On the easternmost of the South Waigat Islands remarkable conditions were encountered. A region about half a mile long, of raised beach or raised sea-floor, was found covered with polygonal markings. Among these there was a *new subtype* of stone-polygon, not, so far as we are aware, previously described, in which the centre of each polygon was composed not of mud but of stones. Although the central stones were of the same type and size as the marginal, they were not arranged in any order, whereas the marginal ones were up-ended. The polygons were unusually small (1–2 feet in diameter) and were totally bare of vegetation. The rock was a partially metamorphosed sedimentary one, of very hard dolomitic shale, splitting into moderate-sized biscuit-like pieces. Transitions were seen from this type to polygons with mud centres, usually mixed with, or at least covered with, a number of stones smaller than those in the borders. The first stage of transition was one in which a very small patch of mud appeared in a central stone area. One such small mud-patch is seen in the centre of the photograph (Plate 6). In this the polygons are all 4–6 feet in diameter, and usually regularly hexagonal. Apparently the presence of mud at the surface of the centres favours the growth in size of the polygons, as was to be expected.

A similar state of affairs, but apparently in an earlier stage (surface almost entirely of stones, arranged only in the borders) was seen on the coast of N.E. Land, not far off to the E.N.E., at Ulve Bay. Here the area of small (1–2 feet) polygons extended for several miles with no distinction between parts of the surface except for the *arrangement* of stones along the "borders." Very rarely localities with a few mud-centred polygons were seen.

Unfortunately the ship did not stay long enough to permit of any excavations being made.

It is known that in mixed mud and stones in the Arctic, the stones tend to come to the surface (Högbom, *op. cit.*, and others). Thus it is quite possible that the all-stone polygons contained mud below their central portions. This is made probable by the fact of *rapid* transition to polygons with mud centres. Furthermore, it would be impossible, on the principles previously laid down, to understand how any arrangement of the stones in the borders could occur unless the central area was at least mainly mud, even if only below the surface. We may therefore prophesy with some degree of assurance that excavation will prove the existence of mud below the central area of apparently all-stone polygons, although of course the question must be settled by further work.

The final fragmentation of the materials of the raised beach or sea-bottom had obviously occurred *in situ*.

A further remarkable type of marking was seen in the same locality on the Waigat Islands, and also in Murchison Bay, N.E. Land. (In the latter locality

the other types of marking just described were not noted.) This type might be classified as intermediate between true stone-polygons and true fissure-polygons. So in a sense it appears to be, but only if we think of the possible history of stone-polygons. It is a *late stage* in the history of such stone-polygons as become converted into fissure-polygons, not an intermediate stable type of equal value with the two main types. The photograph gives their appearance very clearly. They are medium sized (5–6 feet diameter on the average). They possess stone borders, but these are much reduced, both in breadth and in the size of their component stones, in some places being only $\frac{1}{2}$ to 3 inches wide, and only rising very slightly above the general surface. All the rest of the area is composed of fine mud, its surface dotted with small stones.

The mud was very wet. No secondary (small) fissure-polygons were to be seen on it: these appear to be associated with at least partial drying. The photo (Plate 5) shows a less extreme stage in the reduction of the stone border than was noted on the eastern of the South Waigat Islands.

The fact that the stones in the borders are of very different sizes is proof that comminution is going on among them. If this comminution continues, as is of course inevitable under the conditions, the stone borders will become still more reduced, their component stones and those on the surface of the mud still smaller, until finally an area of mud alone will be produced. A further stage in this transformation of stone-polygons to mud is seen in Fig. 1, re-drawn from Nansen. In this figure it appears as if in some places only fissures remained in place of the disappearing stone borders, but one cannot be quite sure from the photo. It is possible that the original position of the stone borders influences the final position of the fissures which in certain conditions will certainly appear in the mud area; but this must be matter for future research.

What is clear is that the view above advanced, that the stone-polygon is merely a relatively stable phase in the weathering of certain types of Arctic surfaces, is confirmed by the existence of these transitional types of marking. In the South Waigat Island locality, the final stages, viz. *large areas of mud only*, are to be found. This locality should be a favourable one for future investigations. After the stable stone-polygon phase is arrived at, the future course of affairs will differ according as to whether the conditions favour the growth of vegetation or not. If not (*e.g.* if the mud areas are completely sodden with water), comminution will continue, and will eventually reduce the whole region to mud. If, on the other hand, the polygons are on a properly drained slope, vegetation will cover them and will tend to stop weathering and comminution. In this case the polygons will be preserved in a "fossil" state for very much longer periods.

If mud is the end-result, in certain conditions fissure-polygons will appear on it, either directly, the fissures occurring where the stone borders had been, or indirectly, the fissures only arising after the area had passed through a stage of uniform mud surface.

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## THE CONQUEST OF MOUNT EVEREST

**Douglas W. Freshfield**

THE departure from our shores of the third party of climbers bent on the exploration and ascent of the highest mountain in the world seems to afford a suitable occasion for recalling some of the circumstances which led to the conception of the Conquest of Mount Everest and for tracing the stages through which a proposal—held at first by most competent judges, including men of science and experienced mountain explorers, extravagant and unrealisable—has been converted, in the opinion of the same experts, into a practical problem which depends for a happy solution mainly on the weather. But good luck in this important matter will need to be supported by the exhibition not only of a firm belief in success and of indomitable pluck—of the latter there is no question—but of sound judgment and of the most meticulous care, a care on the part of the climbing party and its leaders that holds no detail of organization or equipment trivial or unessential. For any remarks I may venture to make on these topics I may plead as an excuse that what I write is largely the result of my own experience in five

mountaineering expeditions among distant ranges. Of these three were to the Caucasus, one to Ruwenzori, and the fifth to the Tibetan–Sikkim–Nepal frontier where the conditions are very similar to those encountered in the approach to Mount Everest.

As I have already reminded the reader, the answer given in the years before the War to the question "Can the highest mountain in the world be climbed?" by the large majority of those qualified to pronounce an opinion was in the negative. Many brilliant climbers had recently attempted Himalayan heights in vain; in vain in so far as that they had been repulsed in their efforts to attain their goal, or to reach any peak of over 25,000 feet. Most of these repulses, it is true, were inconclusive, since to the physical drawbacks incident to exertion at great altitudes had been added serious mountaineering difficulties. There remained, however, one instance which seemed decisive, that of the Duke of the Abruzzi's party in the Karakorum. In that case climbers inured by much past experience on mountains and in Arctic temperatures, and provided with every advantage in the way of equipment that princely resources could procure, were, at an altitude just under 24,600 feet, defeated by difficulty of breathing on an easy snowslope. It seemed therefore reasonable and almost inevitable to infer that about 25,000 feet would prove the limit accessible to mankind, and that the summits exceeding that height might boast permanently of their serene inaccessibility.

There remained, however, a few dissenters from this popular verdict. Of these the most competent and in my own mind the most influential was my friend and former companion in the Caucasus, the late Clinton Dent. Dent, I may remind the general reader, was a distinguished surgeon (at the time of his death he was Senior Vice-President of the College of Surgeons). He was also a brilliant climber, a former President of the Alpine Club, and the Editor of the volume on *Mountaineering* in the Badminton Series. He had seriously studied the physiological problem in question, and his conclusion was put in these words, "I believe most firmly it is humanly possible to ascend Mount Everest, and further I feel sure that even in our own time, perhaps, the truth of these views will receive material corroboration."

For myself I had full confidence in Dent's judgment, despite the apparently formidable array of opinion that could be brought forward on the other side. And I was anxious, before it was too late for me, myself to add another to the list of experiences of high altitudes. In 1890 I discussed with Mummery a joint visit to the Western Himalaya. The project fell through; but nine years later, at the age of fifty-four, I was able to carry out my ambition so far as to spend four weeks at heights varying between 14,000 and 20,000 feet on the northern and western shoulders of Kangchenjunga. The prodigious and exceptional storm of 23 September 1899, which produced a rainfall of 27 inches in

thirty-eight hours at Darjeeling, buried our camp at 15,000 feet on the Zemu Glacier under 40 inches of fresh snow. It obviously put an end to my hope of further testing the limit of human endurance on a great peak. Even to wade across a pass of over 20,000 feet through soft snow of that depth required a serious effort on the part of our fifty coolies, who had to carry besides their own food for three weeks the camp equipment and rations of six Europeans. Only one of the latter felt any serious effects of altitude. We all slept fairly well at about 19,000 feet. The late Dr. Kellas, in subsequent years and under ordinary conditions, ran backwards and forwards over this pass, the Jonsong La, as if it had been the St. Theodul. So far as they went, therefore, our experiences were the reverse of discouraging: the sickness level had for the average man been lifted some 8000 feet from the days of my own boyhood and the early climbers of Mont Blanc. But of course they did not go far, or add any fresh evidence to the controversy. They do however lend marked support to the conclusion of the expedition of 1922, that acclimatization of the human frame to altitude is at least up to 20,000 feet steady and progressive.

During my visit to India Lord Curzon, my former colleague on the Council of the Royal Geographical Society, was Viceroy, and I had opportunities of privately discussing with him the possibilities of Himalayan exploration and the prospect of the political obstacles to any approach to Mount Everest being overcome in the near future.

Six years later, in 1905, Lord Curzon, still Viceroy, wrote to me in London telling me that he believed there was at last some hope of the reluctance of the Nepalese being overcome, and asking me to interest the Royal Geographical Society and the Alpine Club in organizing a Mount Everest expedition. Unfortunately, the Nepalese Durbar subsequently vetoed the proposal, and our relations with Tibet at the time not being of a character to admit of any application in that quarter, all hope of any approach to the great mountain had to be indefinitely postponed.

The war supervened, and it was not until 1919 that the suggested expedition was again considered and seriously taken in hand. The immediate occasion was the discussion following on a paper read by Captain Noel to the Royal Geographical Society on a recent journey in which he had penetrated a short way beyond the Anglo-Tibetan frontier in the direction of Mount Everest. Sir Francis Younghusband, in the first chapter of 'The Reconnaissance,' has described in detail what took place at the Meeting, and I need not repeat the story. The result, in brief, was that the Royal Geographical Society and the Alpine Club agreed to send a deputation to the India Office. There it was sympathetically received by the Secretary of State and referred to the then Viceroy, Lord Reading. In these circumstances, Colonel Howard-Bury most kindly undertook to go to India and personally recommend

the scheme to the Viceroy; and the latter, after some discussion, consented to place our request before the authorities at Lhasa, through the British Resident in Sikkim, Sir Charles Bell, who was instructed to pay an official visit to the Holy City. At Lhasa he was most cordially received by the Dalai Lama, and our request met with the immediate and cordial assent of the Tibetan authorities.

If I have referred in the preceding pages to my own part in the inception of the assault on Mount Everest, it has been mainly in order to furnish a reason for my having at the request of the Mount Everest Committee come forward at the present moment with an estimate of its prospects of a successful issue, and a suggestion, or rather an insistence, on some of the means by which in the opinion of the Committee success may (weather permitting) be reasonably anticipated. In dealing with these and in referring to matters connected with climate, acclimatization to high altitudes, diet, equipment, and general organization I may find occasion to refer to my own experiences twenty-four years ago in a region, the great spurs of the Kangchenjunga group, separated by only 70 miles from the eastern outliers of Mount Everest.

The business of the 1921 Expedition, led by Colonel Howard-Bury, was to investigate the country round Mount Everest and to ascertain the possible approaches to the mountain and the character of the difficulties to be anticipated in climbing it. On these subjects our ignorance was almost complete. General Rawling had reported that seen from a distance of 60 miles to the north the summit did not look inaccessible. Visitors to Sandakphu, near Darjeeling, had observed the final north-eastern ridge and noted its relatively gentle inclination. Signor V. Sella had while travelling with me photographed it from Chunjerma. But this was all; of the configuration of the group, of the relations of its valleys and glaciers, we knew nothing.

The first party carried out successfully their appointed task. Except on the south, where the Nepalese frontier formed for the most part an impassable barrier, their feet encircled the great mountain and penetrated to the inmost recesses of its glaciers. There was but one mischance in the campaign. The climbing party on the Main Rongbuk Glacier, misled by the smallness of the stream—a common feature in the western Himalaya—issuing from a glacier in an eastern side-glen, failed to realize the extent and importance of the névé that gave it birth. Consequently it was not until too late for any practical purpose in that autumn that the upper region of the East Rongbuk Glacier was reached by a circuitous route over a pass from the Kharta Valley. It was thus ascertained that from its head the gap, immediately under the flank of Mount Everest, in the ridge between it and the North Peak that separates the Main and East Rongbuk Glaciers, was accessible by mounting 1000 feet of broken but moderately inclined snowslopes, safe in ordinary conditions if liable at times to avalanches. As it had

previously been observed that the face of the mountain above the gap was a rock-slope offering no insurmountable obstacles, the main object of the Reconnaissance had been effected—a way had been found for a serious assault in the succeeding years.

The party brought back, however, from their meteorological experiences an unexpected and somewhat surprising conclusion. They argued that the early summer, the period before the monsoon, was likely to be a more favourable season than the autumn for mountaineering in the western Himalaya. In this they went, on the whole, against the practice of earlier climbers in Sikkim, most of whose successes had been won in the later period of the year. My own experience was remarkable. I have mentioned the phenomenal snowstorm of 23 September 1899. For the following weeks up to the end of October the weather was continuously fine and the forenoons as a rule cloudless, while we enjoyed complete absence of wind. But there seem to be few Septembers without snowfalls, such as may make the highest peaks for a time dangerous or inaccessible. Moreover, the photographs taken by the second party show convincingly that rockfaces laden in autumn are mostly bare in early summer. This may prove a decisive argument for the earlier season. And there is also the relative degree of cold to be considered; in summer the frost is less intense. The Norwegians on Kabru in 1907 at a height of 22,600 feet suffered a temperature 23° below zero Fahr. At the fourth camp Mr. Mallory records at 25,000 feet one of 7° F. above zero; at my camp at 19,767 feet the temperature was by day 32°, but at night inside the tent 5° F.

From the story of the two assaults on the mountain in 1922 told by Mr. Mallory and Captain Finch their successors may gain many suggestions and some warnings. Mountaineers climb on the shoulders of their forerunners as on stepping-stones:

"The many fail, the one succeeds."

But his success is the fruit of the lessons gathered from the efforts, and sometimes from the omissions or mistakes, of those who went before him and reduced the problem to be solved to more manageable proportions:

Νικᾷ δ' ὁ πρῶτος καὶ τελευταῖος δραμών.

The foremost fact established by the climbers of 1922 is that Mount Everest presents for the most part what in the Alps would be held an easy rock climb. There are few great Alpine rock peaks so safe that an indisposed man can be safely sent back alone. Telephotographic views have revealed to us not only the character but the details of the northern rock face. We can estimate the relative advantages of striking at the ridge directly from the Chang-La or of keeping on the face below it on the line taken by Finch and Bruce. The former course in calm weather is probably preferable. The ridge rises gently and the breaks—low cliffs—in it look manageable. It has been pointed out

that if the slope of the final cupola were found hard ice, step-cutting at 29,000 feet might prove beyond human powers. But the photographs show a horizontal ledge running round on the right to rocks that seem to conduct directly to the summit.

I must now venture some remarks on a delicate subject: The discipline and control of the climbing party; they are founded in great part on my own experience. Free discussion in camp of the various problems that come up from day to day is stimulating and exhilarating. So long as it does not assume the warmth that the high and thin air is apt to generate, it helps to pass long hours. But when the time for action comes the discipline should be military, and the decision of the chief once framed should be carried out unreservedly. So long as the summit of Mount Everest is gained, who cares whether it is with or without the use of oxygen? One might as well claim merit for going up the Matterhorn without a rope or an ice-axe, in dress-shoes or shirt-sleeves. A more tragic parallel may be found in the unfortunate prejudice against the use of sledge dogs shown by British parties in the Antarctic.

The leader of the climbing party should have the general plan clearly set out in his own mind and organized in every detail of equipment and provisionment. First he will need to establish Camp 4 on the Chang-La as an efficient base, well stored with available wraps and provisions and means of cooking them, and habitable for a sufficient gang of porters who would be relieved from time to time. One of his more important duties will be the arrangement of these parties of natives, whose business it will be to prepare the highest camp. The leaders of these parties should be Europeans who have nobly renounced the glory of the *first* ascent. The members of the small storming party should be sent up as little exhausted as possible to a camp made as endurable as forethought can make it, and suitably provisioned. This is the most essential matter of all.

Next he will consider the number of climbers to undertake the last assault. How many climbers should be chosen is, I am aware, a much-debated question. With all due deference to a younger generation, I gravely doubt the expediency of sending a party of two. No doubt two move somewhat more quickly, especially on difficult rock climbs. But on a long and great and relatively easy ascent a party of three has obvious advantages. If one is disabled two can more easily render assistance than one; again, one can hurry for further aid while the other remains with the sick or injured man. I believe three to be a suitable number; but if this opinion does not prevail I would venture a further suggestion. Why should not two separate parties, two in each, be sent off simultaneously? One party would assist the other in case of any accident or sickness, and three or two climbers could go on as might seem best. The chances of success would be greatly increased. On the other hand it may be argued that the highest camp would have to

be doubled, that is, to consist of two tents in place of one and proportionate wraps and provisions. It would be well if a system of signalling were established between the final camp and that on the Chang-La. This highest camp must not be under 27,000 feet. If the climbers can make 400 feet an hour above this elevation (and more than this is doubtful), it will take them five hours to get to the top. Building a stone man is apt to be exhausting work at any elevation; they should carry a pole and a flag to set upon the summit.

Let us now turn to details of equipment and diet. There were far too many casualties from frost-bite in the last expedition. Other climbers and many polar explorers have endured lower temperatures without so much serious suffering. By a universal adoption of something resembling arctic equipment, it ought to be possible to avoid such disastrous experiences as those recorded. With more carefulness in avoiding exposure of hands and ears, and by the universal use of wind-proof garments, the disabling of a party at a critical moment may, we must hope, be prevented. Boots, it need hardly be said, should be placed under the head at night, where they may escape being frozen. Hot-water bottles and air cushions are light to carry, and great helps to comfort on cold nights on hard rocks. The only drawback to the indispensable sleeping-bag is the difficulty of getting yourself and your porters out of it in a low temperature. But as early a start as possible should be insisted on. The days are short near the tropics.

Lastly as to diet. Digestions may differ, but there is a general assent as to the nature of the foodstuff that is most palatable at great heights, and the expedition is sure to be provided with every suitable luxury. It would be impertinent to go into details. Is there not the Badminton volume on Mountaineering? In my experience the one essential is that the meals, or snacks, should be *frequent* and light, but I am impelled by certain passages in the "Assault on Mount Everest" to deprecate, after laborious climbs, Gargantuan feasts such as are there recorded. I may quote what Clinton Dent wrote in the volume mentioned: "When the entire body is in need of rest before anything else, it is injudicious to throw on it the labour of digesting a heavy meal." It is, in fact, an indulgence calculated to impede the recovery to normal health and powers. On the other hand the risk of starvation such as befell Captain Finch and Captain Bruce must be most carefully guarded against. That in all the circumstances they accomplished what they did is one of the most surprising and bravest feats of mountaineering on record.

Before putting down my pen I take the opportunity to make a suggestion from the point of view of a geographer. It is, of course, most desirable that no risk should be run of offending the sensibility of the Nepalese statesmen. But we have learnt that the frontier of Nepal and Tibet in the Chomolungma group runs for the most part not along

the watershed but across the southern gorges. A parallel instance may be noted in the Teesta Valley in Sikkim, where Sir J. Hooker had pointed out to him the frontier of China at the Zemu bridge close to Lachen, and many miles south of the watershed. It would seem to follow that there should be no obstacle or objection to our mountaineers exploring any of the southern glaciers and upper valleys that are in Tibet. We have learnt that they are accessible from the north by much-used passes. It would be a most interesting addition to knowledge to extend our map to the region in question and to obtain photographs of the great southern cliffs of Mount Everest that are so conspicuous an object in the distant views from the spurs of Kangchenjunga. May I, in conclusion, since I have been led to mention that magnificent mountain, express my earnest hope that, after the conquest of Mount Everest, some members of the party may have time and energy to reconnoitre the north-west flank of Kangchenjunga from one of the heights above Pangperma at the head of the Kambachen Valley—the only quarter that seems to afford some prospect of a possibly practical line of attack?

In this connection I would add, in the interest of future travellers and mountain-lovers, a modest petition to the local authorities, or the Government at Calcutta, whichever it may concern. Since my visit in 1899 the pony paths up the Teesta valley have been improved and repaired, and—though they were not thought good enough for the heavy transport of the Mount Everest parties—Lord Ronaldshay found it possible to ride up the gorges past Lachen to the Tibetan frontier. But no path has so far been made up the 10 miles of the side valley that leads to the Zemu Glacier. The ground is not difficult, and it would be relatively a small matter to clear a track through the rhododendron jungle to the bare pasturages beside the great ice-stream. Here at a height of about 15,000 feet the traveller comes on the Green Lake Plain, a large meadow of Alpine flowers at the very base of the fluted snow-cliffs of Siniolchum and the gigantic precipices and soaring ridges of Kangchenjunga itself. This spot will in future be counted among the sights of the Himalaya and the wonders of the world. To make it reasonably accessible by a track, and by erecting a rough stone hut of the type common in the Alps, or even like that at Jongri, would be an undertaking that would earn the gratitude of posterity. Until this is done the Himalayan traveller, even if he be a Lieutenant-Governor, will run the risk of missing by a few miles one of the most superb spectacles on the face of the globe. The local conditions will perhaps be rendered more clear to the majority of my readers if I remind them of a parallel case. How many generations of travellers passed Visp on their way to the Simplon without realizing that the Matterhorn and Monte Rosa lay but a short day's walk up the valley on their right?

It may perhaps be said that this suggestion has no connection with

the Mount Everest Expeditions. I hold the contrary. Whether or not the highest mountain in the world falls this year to our assault there is no doubt that a strong stimulus will have been given to the exploration and climbing of the Himalaya, and that one of the first regions to be explored in detail must be the ranges of Sikkim, since they are both politically accessible and conveniently close to a great hill station, Darjeeling. The day cannot be far off when in India as in Europe the truth of the eloquent eulogy of the physical and moral benefits to be derived from mountaineering lately put forth by a very high authority will be recognized and acted on. For the benefit of those who ask the use of the assaults on Mount Everest I may conclude by quoting a portion of Pope Pius XI.'s recent letter to the Bishop of Annecy on the occasion of the thousandth anniversary of the birth of St. Bernard of Menthon, the founder of the hospices on the two passes that bear his name:

"Of all the exercises which afford us a wholesome distraction there is—for a man who knows how to avoid rashness—none more serviceable than Mountaineering in promoting both health of body and vigour of mind. In his laborious effort to attain the mountain tops, where the air is lighter and purer, the climber gains new strength of limb; while in the endeavour to overcome the various obstacles of the way the soul trains itself to conquer the difficulties of Duty: and the superb spectacle of the vast horizons which from the highest crests offer themselves on all sides to his eyes, raises without effort his spirits to the divine Author and Sovereign of Nature."

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## THE ROSS DEEP

Lt.-Comm. R. T. Gould, R.N. (retd.).

A SINGLE deep-sea sounding, and an erroneous one at that, which produces for sixty years afterwards a most definite and extensive effect upon the views of geographers and oceanographers, may justly be considered an almost unique phenomenon; and such is the famous sounding of "4000 fathoms, no bottom," which Sir James Ross believed that he had obtained, during the third year of his famous Antarctic voyage, in lat. 68° 34′ S., long. 12° 49′ W.

Ross's well-deserved reputation as a scientific navigator and explorer, and the attention which he devoted during the voyage to the technique of deep-sounding, combined to obtain general acceptance of this result, with the result that the "Ross Deep" in this position became a familiar feature on bathymetrical and other charts, and that the hypothetical outline of the Antarctic Continent in this region was plotted, as after events proved, a long way too far southward. For example, the late Sir John Murray, in the course of a paper on the scientific advantages

of an Antarctic expedition, read before the Royal Society on 24 February 1898, remarked :

> " To the south-west [should be south-east *R. T. G.*] of South Georgia, Ross paid out 4000 fathoms of line without reaching bottom. In the charts of depth which I have constructed, I have always placed a deep sea in this position : for it appears to me that Ross, who knew very well how to take soundings, was not likely to have been mistaken in work of this kind."

Until 1904 the region of the " Ross Deep " remained unvisited by any subsequent explorer, but on March 23 of that year the *Scotia*, under Bruce, obtained, with modern appliances, 2660 fathoms, blue mud bottom, in a position which, by her observations, agreed within a mile of that reported by Ross, and which, even allowing for the difficulties of accurate navigation in the Antarctic, was undoubtedly within a few miles of the actual spot where Ross sounded.

The *Scotia's* sounding not only caused the removal of the " Ross Deep " from the charts, but tended also to cast grave suspicion upon all of Ross's soundings, especially when the primitive nature of his appliances was considered. He used a 9-stranded hemp line, approximating in size to cod line (half-inch circumference) coiled upon a large wooden reel in one of the ship's boats. It was suggested, as the most probable hypothesis, that, certainly in the case of the 4000-fathom sounding, his line had been run off, during the later part of the time, by a strong under-current, whose pull had caused the actual striking of the bottom to be passed unnoticed.

Recent investigations into the details of some of his soundings has thrown some additional light on this point. A copy of a contemporary report addressed by Ross to Admiral Beaufort, then Hydrographer, has recently been discovered in the Hydrographic Department, and by the permission of Admiral F. C. Learmonth, R.N., Hydrographer of the Navy, I am enabled to quote it here. It amplifies very much the short account given by Ross in his book,* and leads to a somewhat remarkable conclusion, namely, that the data available, if analysed at the time, would have indicated clearly that bottom *had* been struck, at a depth not exceeding 2200 fathoms.

Ross's report, which was received by Beaufort on 7 July 1843, is as follows :

*Account of an attempt at Soundings, in lat.* 68° 34′ *S., and long.* 12° 49′ *W., made in the boats of H.M. Ships " Erebus " and " Terror," on* 3 *March* 1843.

The wind continued light from the S.W. until 11 a.m., when it fell quite calm. I seized the opportunity of ascertaining the temperature of the ocean at 750, 600, 300, and 150 fathoms, and in the afternoon, the sea having become perfectly smooth and the calm still prevailing, our boats were lowered down, and the experiment of deep-sea sounding attempted. I regret that, owing to

* 'A Voyage of Discovery and Research in the Southern and Antarctic Regions during the Years 1839-1843.' London : 1847.

our having always found Soundings in less than 2000 fathoms in other parts of the Antarctic Sea, I had not prepared more than 4000 fathoms of line for this occasion.

The whole ran off the reel without striking ground. The experiment was most satisfactory and perfect under the management of Commander Bird in the Sounding boat.

The experiment was conducted in the manner I have already described, and the time of each hundred fathoms passing out was obtained by me, and recorded by Captain Crozier. A copy of the original paper is annexed.

The weight employed was 340 lbs.

The first 250 fathoms of line was of 12 yarns, the rest (3750 fms.) of 9 yarns, and the whole was prepared in equal proportion by the crews of the *Erebus* and *Terror*.

The Current was found to be setting to the S.W. at the rate of 0·3′ per hour, which almost inappreciable quantity may be fairly ascribed to the influence of the light N.E.ly. wind that had sprung up. . . .

JAS. C. ROSS.

DEEP SOUNDING, 3 MARCH 1843.

| *Fms.* | *Mark.* | *h.* | *m.* | *s.* | *m.* | *s.* |
|---|---|---|---|---|---|---|
| Let go | 0 | 11 | 21 | 32 | | |
| 100 | Green | | 22 | 11 | 0 | 39 |
| 200 | Black | | 23 | 1 | 0 | 50 |
| 300 | Flannel | | 24 | 9 | 1 | 8 |
| 400 | Canvas | | 25 | 23 | 1 | 14 |
| 500 | Cheque | | 26 | 50 | 1 | 27 |
| 600 | Duck | | 28 | 22 | 1 | 32 |
| 700 | Red | | 29 | 59 | 1 | 37 |
| 800 | Grey | | 31 | 38 | 1 | 39 |
| 900 | Blue | | 33 | 21 | 1 | 43 |
| 1000 | Red Ribbon | | 35 | 11 | 1 | 50 |
| 1100 | Green | | 37 | 8 | 1 | 57 |
| 1200 | Black | | 38 | 57 | 1 | 49 |
| 1300 | Flannel | | 41 | 0 | 2 | 3 |
| 1400 | Canvas | | 43 | 7 | 2 | 7 |
| 1500 | Cheque | | 45 | 15 | 2 | 8 |
| 1600 | Duck | | 47 | 27 | 2 | 12 |
| 1700 | Red | | 49 | 45 | 2 | 18 |
| 1800 | Grey | | 52 | 3 | 2 | 18 |
| 1900 | Blue | | 54 | 23 | 2 | 20 |
| 2000 | Red Ribbon | | 56 | 46 | 2 | 29 |
| 2100 | Green | 11 | 59 | 11 | 2 | 25 |
| 2200 | Black | 0 | 1 | 38 | 2 | 27 |
| 2300 | Flannel | | 4 | 16 | 2 | 38 |
| 2400 | Canvas | | 6 | 56 | 2 | 48 |
| 2500 | Cheque | | 9 | 58 | 3 | 2 |
| 2600 | Duck | | 13 | 28 | 3 | 20 |
| 2700 | Red | | 16 | 58 | 3 | 30 |
| 2800 | Grey | | 20 | 48 | 3 | 50 |
| 2900 | Blue | | 24 | 58 | 4 | 10 |
| 3000 | Red Ribbon | | 29 | 5 | 4 | 7 |
| 3100 | Green | | 33 | 20 | 4 | 15 |
| 3200 | Black | | 37 | 44 | 4 | 24 |
| 3300 | Flannel | | 42 | 11 | 4 | 27 |
| 3400 | Canvas | | 46 | 31 | 4 | 21 |
| 3500 | Cheque | | 50 | 50 | 4 | 19 |
| 3600 | Duck | | 55 | 16 | 4 | 26 |
| 3700 | Red | | 59 | 50 | 4 | 34 |
| 3800 | Grey | 1 | 4 | 22 | 4 | 32 |
| 3900 | Blue | | 8 | 52 | 4 | 30 |
| 4000 | Red Ribbon | | 13 | 21 | 4 | 29 |

The data afforded by these lengths and times have been plotted on the attached diagram, and a smoothed curve drawn through them to assist the eye. It will be noted that the intervals between the running out of each 100-fathom mark exhibit a progressive and regular retardation in the speed of the line until about 2200 fathoms are out, when there is a sudden and well-marked increase in the retardation, which remains almost constant for some time, and is followed by fluctuations.

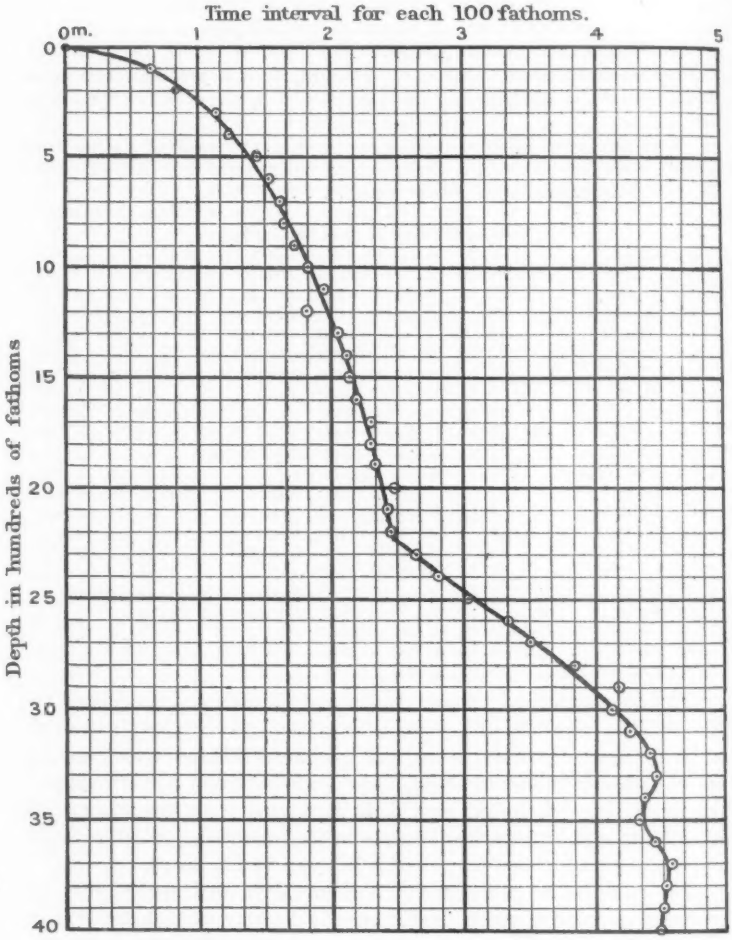
The cusp in the curve at 2200 fathoms is so well defined that its existence is unquestionable, and there can be very little doubt that it was occasioned by the sinker striking the bottom, at which point the gross weight of line out would be about 150 lbs.*

* This figure is taken from a small pamphlet 'Notes on Deep Sea Sounding' published by Staff-Commdr. J. E. Davis in 1867. Davis was second master of the *Terror*, Ross's consort in his Antarctic voyage, and was afterwards employed for many years in the Hydrographic Department.

The fluctuation beginning at about 3200 fathoms is not so easy to explain, but it is probably the effect of under-current.

It may be noted that if, instead of using the intervals as abscissæ, the elapsed times from " Let go " are employed, the cusp in the resulting

SOUNDING OF THE "ROSS DEEP"




curve is almost imperceptible, and that if, on the other hand, the second differences of the intervals are used, the significance of the curve is totally masked by the accidental errors, in which the friction of the reel probably played a considerable part.

There fortunately exists, for comparison with the above data, similar information (printed in his book, pp. 320, 321, vol. 1) relating to a sounding of 1540 fathoms obtained by Ross in lat. 52° 10′ S., long. 136° 56′ E., on 4 April 1841. These afford, up to that depth, a curve coinciding exactly with the corresponding portion of the graph of the 4000-fathom sounding. This goes a long way to support the view that the curve on the diagram, as far as 2200 fathoms, represents the unchecked descent of the sinker, and that the cusp is due to the latter having struck bottom. This sounding of 1540 fathoms has not been subsequently verified, but there is a modern one of 2150 fathoms about 100 miles east-north-east from it.

Ross repeated "the experiment" subsequently, on 3 June 1843, in lat. 15° 3′ S., long. 23° 14′ W., and obtained a similar result of "4600 fathoms, no bottom." I have not been able to find details of this sounding, but there seems no doubt that, like its predecessor, it was fallacious. It lies about midway between two modern soundings of 2710 and 3072 fathoms respectively.

When one considers the enormous amount of oceanographical and other work which Ross, practically unassisted by a scientific staff, and handicapped by his arduous duties and responsibilities as leader of the expedition, undertook and completed in the course of this celebrated voyage, the wonder is not that he made mistakes, but that he did not make more. Unsuspected defects in his thermometers vitiated his deep-sea temperatures; one or two of his "appearances of land" are more than suspect; and his "Parry Mountains" have long since disappeared from the charts. His deep-sea soundings may perhaps, in the light of more modern work with far superior appliances, be relegated to the same category. But his magnetic and geographical results still stand unrivalled for extent and completeness, and more than justify his claim to be regarded as the greatest and most successful of Antarctic explorers.

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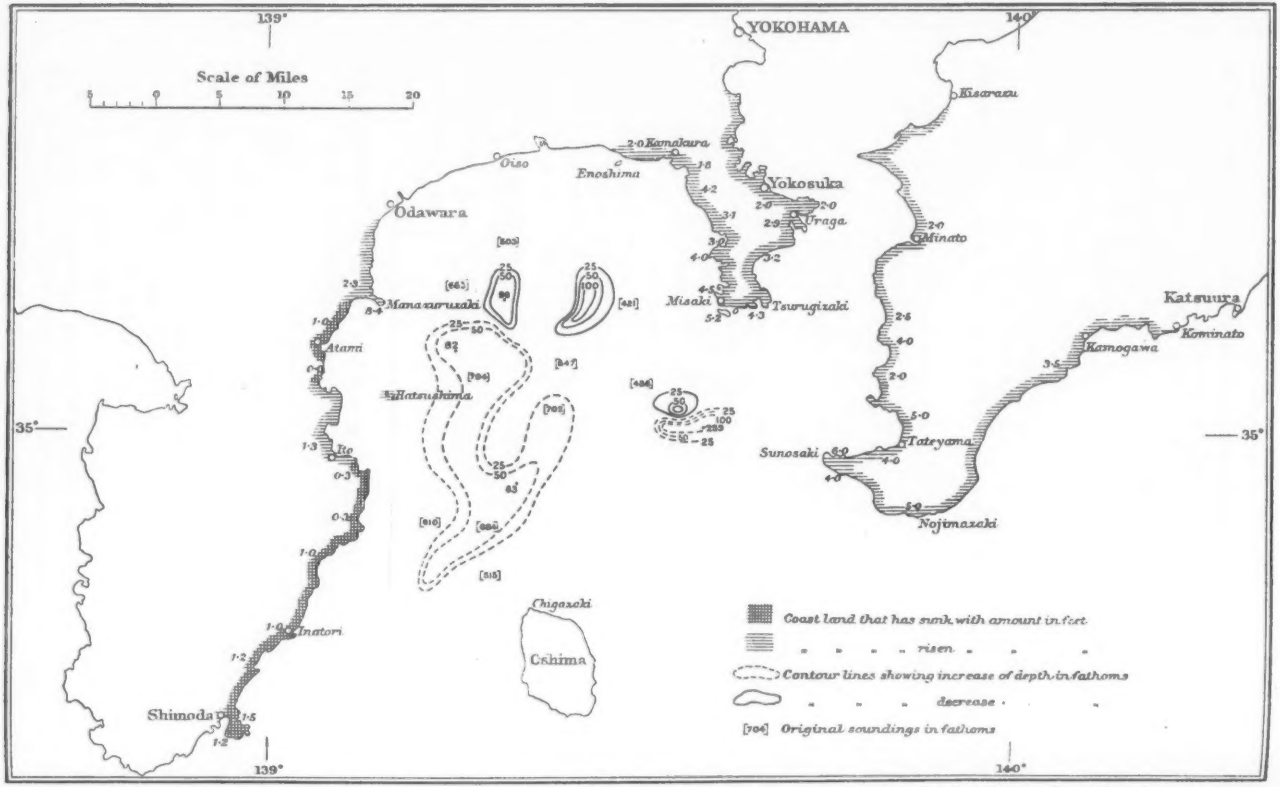
## DISTORTION OF THE SEA-BED IN THE JAPANESE EARTHQUAKE OF 1 SEPTEMBER 1923

THROUGH the courtesy of the Secretary of State for Foreign Affairs, the Society has received two charts of very great interest forwarded by the Naval Attaché to H.M. Embassy at Tokyo. The first of these maps shows the changes of elevation of the shores of Sagami Bay and Tokyo Bay, and the second the changes of depth in Sagami Bay. These charts are the result of a preliminary survey only, and some time must elapse before the results of a detailed and accurate survey will be available. They are reproduced in the accompanying map. The shading along the coast shows where changes of elevation have occurred. Shading with single lines indicates the tracts that are raised, and shading with cross lines those which are lowered. Along the west coast of Sagami




Preliminary Sketch-map of changes in the sea-bed and on the coast of Sagami Bay, at the time of the Japanese Earthquake of 1 September 1923, communicated by the Hydrographic Department of the Japanese Navy to the British Naval Attaché.

Bay the rise is small, being in no place greater than 2·3 feet. The maximum elevation—7·1 feet and 8·4 feet—occurs in two small islands to the east of Atami, though at several points near the entrance of Tokyo Bay there is a rise of 5 or 6 feet. The depression of the coastline is much less, being at no point more than 1·5 feet.

Interesting as these movements are, they are insignificant compared with the remarkable changes in the depth of Sagami Bay. The broken lines in the map are curves of equal subsidence, the dotted lines curves of equal elevation, the broken and dotted line between the two series of curves representing the line of no displacement. In each case the outer line is a curve of elevation or depression of 25 fathoms, and the inner curve or curves of 50 or 100 fathoms. It will be seen that there are three small areas of elevation, the maximum uplifts, from west to east, being 96, 113, and 135 fathoms. In the large area of subsidence, the maximum depression is 63 fathoms; in the ill-defined area in the north of Sagami Bay 166 fathoms; and in the small area to the east no less than 259 fathoms.

Considerable changes in the depth of the sea have been observed before in the epicentral areas of other earthquakes, but in no case have they been so free from doubt as the recent changes in Sagami Bay.

Several points of much interest arise from these observations: (i.) The first of course is the magnitude of the changes in the sea-bed as compared with those along the coastline. (ii.) More important still is the extraordinary distortion of the crust resulting from the movement that caused the earthquake, and the rapidity with which elevation passes into subsidence. In the eastern areas, the north end of a line 1½ miles long is raised 810 feet and the south end lowered 1224 feet. Before the earthquake the sea-bed along this line was inclined at an angle of 19° to the north; after the earthquake the slope was reduced to 5° in the same direction. (iii.) Taking into account these great changes in the sea-bed, it is strange that the sea-waves following the earthquake were so small. At Kamakura and elsewhere along the coast, no wave of more than 20 feet high is reported. Is it not possible that the changes in depth occurred intermittently, some of them perhaps in connection with the more important after-shocks?

C. DAVIDSON.

Preliminary Sketch-map of changes in the sea-bed and on the coast of Sagami Bay, at the time of the Japanese Earthquake of 1 September 1923, communicated by the Hydrographic Department of the Japanese Navy to the British Naval Attaché.

## HIMALAYAN GLACIATION

**Spedizione Italiana De Filippi nell' Himàlaia, Caracorùm e Turchestàn Cinese (1913–14).**— Series 2. *Resultati geologici e geografici*, vol. 3. Studi sul Glaciale. **Giotto Dainelli.** 4to. Pp. 651. 73 *Illustrations, and Appendix with* 177 *plates*. Bologna: Nicola Zanichelli. [1923.] *Price of both series complete, lire* 2500.

THIS is the first instalment of the monumental work on the scientific results of Dr. de Filippi's expedition to the Himalaya, the Karakoram, and Chinese Turkestan during 1913–14. The second series, of ten volumes,

is edited by Prof. Giotto Dainelli, who himself contributes the present volume on the Glaciology of the region visited. The district examined by Prof. Dainelli consists essentially of two distinct areas: (1) the Upper Indus and its tributaries comprising the territories of Baltistan and Ladak, and (2) the Basin of Kashmir. The first 455 pages are devoted to a description of the glacial phenomena of the Upper Indus valley and its tributaries, while 129 pages are occupied by a description of the Kashmir basin. The volume concludes with a general survey of the Glacial Period in these two districts. In the portion devoted to Kashmir the author considers the origin of the Kashmir basin and deals with the literature bearing on this question; he also discusses the evidence for the former existence of a large lake occupying the vale of Kashmir. A considerable space is given to a discussion of the evidence in favour of a recent elevation of the Pir Panjál range. This elevation was postulated by Godwin Austen, Lydekker, Neve, and Middlemiss from observations on the dip of the old lake deposits or "Karewa" on the flanks of Pir Panjál, which in places show a dip of 20° to the east, while the deposits on the flanks of the Himalaya opposite remain practically horizontal and occur at a lower level. Prof. Dainelli gives a diagram to show (1) that this elevation was in the form of an anticlinal axis; (2) that it reached a maximum of 2000 metres or more; and (3) that the line of maximum elevation corresponds with the position of Tataculi, which at the present day forms the highest point of the range.

The general result of the work on the glaciology of the district goes to prove the former greater extension of glaciation in the Upper Indus valley and the Kashmir basin. The existence of a glacial period in the Indus valley has been denied by many of the previous writers, though Medlicott and Blandford, while doubtful whether the Himalayan glaciers ever spread over the low ground in great sheets like those of Europe, admitted that in places where the mountains rise steeply from the low ground, as in the Kangra valley, glaciers may once have reached to within 2000 feet of sea-level. The earlier portion of the volume contains a review of the literature bearing on this subject, and Prof. Dainelli discusses the views expressed by Diener, Drew, Lydekker, Oestreich, and others.

One argument which has been brought forward by some previous writers, especially Falconer, against the former extension of the present Himalayan glaciers to lower levels, is the absence of lakes comparable to those of Lugano and other large lakes in the Alpine district. The author admits the absence of large lakes at the foot of the mountains, and also the comparative scarcity of lakes in the upper basin of the Indus. As a set-off to this, however, he points out the abundance of lakes in the upper basin of the Jhelum in the Kashmir district. He also cites the case of the Caucasus, where lakes are absent but where extensive glaciation must have taken place in the Quaternary period.

Prof. Dainelli made a personal study of the lakes of the Upper Indus lying between its confluence with the Gilgit on the west and the plains of Kashmir on the east. From this district he cites fifty lakes and groups of lakes. Many of these are moraine-dammed, but some of the larger ones, as the Satpor Tso, the Tso Moriri, the Chiun Tso, and the group of lakes associated with the Pángong Tso, he considers to have originated by glacial excavation. In addition to these, many lakes which formerly existed have been drained or filled up. Apart from the relative scarcity of lakes, however, the chief fact of morphological significance is the remarkable scarcity of corrie lakes and the general absence of cirques. This absence may be attributed, in part, to the fact that we are dealing with the edge of a high plateau region of great elevation

where erosion is much advanced so that the valleys are very deep and the flanks precipitous, leaving little room for the formation of cirques ; but a further and more important feature is the position of the mountain crests which, owing to their great height, are still covered by glaciers which prevent the cirques from being seen. This explanation appears to be borne out by comparing the basin of the upper Indus with that of Kashmir, a description of which occupies the later portion of the volume. In Kashmir the crests of the ranges lie at a much lower elevation, so that at the present day we find a relatively small development of glaciers, but a greatly increased number of cirques and corrie lakes. In pre-glacial times the region must have been characterized by a topography differing considerably from that of the present day. In the eastern zone—that is to say, in the upper Ladákhan Indus, the region of enclosed basins and round the Depsang—the country had a much more marked high plateau character than that of the Rupshu and the Depsang to-day, whose topographical surface must have been much more extensive than at the present day.

As we pass from the north-easterly zone of Ladákh further and further to the west the character of high plateau becomes less marked. During the Quaternary Glacial Period the ice advanced until it covered the whole of the Upper Indus valley, at least as far as its confluence with the Gilgit. Dr. Dainelli's detailed researches on the glacial deposits of the Upper Indus has led him to recognize four successive expansions of the ice, followed by others of considerably less intensity. The two first were characterized by a different development from the later ones. During the first extension most of the valleys were invaded by ice, whereas in the later stages the Indus valley and most of the zone of the high plateaux was free from ice. Though it is difficult to say absolutely, it appears that the first advance was more intense than the second, and the third though less intense than the second was more so than the fourth. The succeeding extensions were considerably less important, and, in accord with the terminology of Penck and Brückner, are given the name of " Stadi."

The author gives figures to show the relative extent of the surface occupied by ice during these periods of advance, from which it appears that over a region of 100,000 square kilometres in the Upper Indus, of which one-tenth is occupied at the present time by ice, nearly two-tenths were ice covered during the fourth extension, three-tenths during the third, five-tenths during the second, and a still great area during the first glaciation. The first extension is correlated by Prof. Dainelli with the Mindel Period in the Alps. The second with the Riss, the third with the Würm, while the fourth is considered to correspond with the oldest post-Würmian extension in the Alps.

It is thought to be not improbable that during both the first and second extension the Indus glacier reached the mouth of the valley and debouched on to the plains, and it is certain that the glaciers on the Himalayan slopes of Kashmir extended to the plains of Kashmir. Pir Panjal, which lay below the snowline, had certainly no valley glaciers, and perhaps no cirques, and at the end of the first extension even some of the present-day characters may have been apparent. During the third extension, corresponding to that of the Würm, the snow-line on the Kashmir slopes of the Himalaya must have lain some 500 metres higher than during the second extension. The height seems to have varied from 3500 metres in Kashmir to a maximum of 5750 metres in the zone of the high plateaux of the Depsang, the essential feature of this third extension being that the Indus valley had no glacier of its own though the glaciers of the lateral valleys reached to the main valley. One of these descended by the Kul valley, reached the Skardu basin and dammed the Indus, forming

a lake which extended into Baltistan, while other glaciers, the Shigar and Shayok, reached the lake which expanded into the mouths of such valleys as were unoccupied by glaciers. This flooding was so intense in the Indus valley between Saspul and Fe, owing to the high relief, that a small lacustrine basin was formed in the mountains between Fe and Himis. Below Skardu similar phenomena were caused by the glacier debouching from the Astor valley. In the upper Shayok the glacier blocked the valleys of Tankse and Kiang-Kemmo, giving rise to lacustrine basins. Elsewhere the edges of the high plateaux near the Himalayan watershed—the Rupshiu and the Deosei—had their mantle of ice, though in a lesser degree, and sent ice-streams to the opposite slopes. Small glaciers were also in existence in the zone of the Eastern Karakoram, but did not reach the main valleys. On the Kashmir side of the Himalayas the glaciers no longer reached the basin of Kashmir, where the deposits laid down in the large lake which came into existence during the first interglacial period and vanished during the second interglacial period, were terraced for the first time.

The third interglacial period was occupied chiefly in the removal of the deposits of the third glaciation. To this time also is attributed the powerful movement of upheaval in the character of an anticlinal marginal axis which raised the Pir Panjal range in Kashmir to its present height.

The fourth extension, corresponding to the most ancient post-Würmian extension in the Alps, found the glaciers in the lateral valleys much less advanced than during the third extension, and only a few reached the main valley. The glaciers of the Shigar and the Shayok no longer united into a single tongue. In Kashmir the glaciers on the Himalayan side were also more restricted, but the Pir Panjal range now had glaciers for the first time owing to its recent elevation. These took the form of both valley glaciers and hanging glaciers. Intense alluvial deposits were accumulated at this period, and determined the formation of numerous lacustrine basins in the Rupshu. The snow-line was not 150–200 metres higher than in the period of the third expansion, varying from a minimum of about 3800 metres in Kashmir to a maximum of about 5800 metres in the plateaux region of Depsang.

The work is illustrated by drawings in the text, and is accompanied by a volume containing a series of maps and photographs. The most important maps are those of the Skardu basin on the scale of 1/100,000, giving the Quaternary deposits, those of the Kashmir basin on the scale of 1/300,000, and a map of the upper basin of the Indus on the scale of 1/100,000 portraying the probable glacier systems and lakes which existed during the third expansion of the ice in the district.

Of the photographs it is difficult to speak too highly, whether we consider their abundance, the careful selection of subjects, or the admirable way in which they have been reproduced. Some of the most striking are the panoramas of the Skardu valley and its deposits, the high plateaux of Depsang, the glaciated rock surfaces of Olting, and the erosion forms in the Lamaium valley. The series of photographs as a whole brings out most conspicuously the desolate character of the region, which with its bare rock surfaces and absence of vegetation, must indeed be a paradise for geologists.

We congratulate Prof. Dainelli on the completion of a very admirable and important piece of work. E. J. GARWOOD.

## THE TIBETAN BORDER

**The Mystery Rivers of Tibet.— Captain F. Kingdon Ward.** London: Seeley, Service & Co. 1923. 9 × 5½, pp. 316. *Sketch-maps and Illustrations.* 21*s. net.*

**To the Alps of Chinese Tibet.— J. W. and C. J. Gregory.** London: Seeley, Service & Co., Ltd. 1923. 9 × 5½, pp. 322. *Map and Illustrations.* 25*s. net.*

THE appearance almost at the same moment of two books of travel describing the remote corner where Western China borders on Eastern Tibet shows that this most interesting part of Asia is receiving the attention that it deserves. It is also a sign of the times that the authors are not only explorers hoping to be able to traverse some unsurveyed country, but are men of scientific reputation with a definite object in view—botanical collection in the case of Captain Kingdon Ward, and the solution of a most interesting geological problem in the case of Prof. Gregory and his son. Though both are chiefly interested in their own branches of science, they have evidently spared no pains to add also to our knowledge of the country, its inhabitants, products, and natural history. Somewhat different methods have been adopted in the two books. In one the botany is scattered throughout the book, in the other the geology is chiefly confined to the first and last chapters. Both authors have perhaps been wise in the plans they have followed. Descriptions of forests and flowers can with Captain Kingdon Ward's pen be made to add much to his pictures of the scenery. An account in detail of the discoveries which led Prof. Gregory to his conclusions on the geology of the country might be unintelligible to the general reader unless accompanied by much explanation. It should be noted also that 'The Mystery Rivers of Tibet' describes a journey made in 1913–14, while 'To the Alps of Chinese Tibet' is an account of travels as recent as 1922. The conditions here however do not change much, and both books may be said to give an equally faithful picture of travel at the present day.

Captain Kingdon Ward is already well known as the author of two previous books on the same part of the world, and in the present volume he fully maintains his reputation as an experienced and keen observer who describes what he sees in a readable manner. Most of his botanical expeditions were undertaken within a few days' march of Atuntze, a place which he made his headquarters for a time. In the autumn of 1913, when the plant-collecting season was over, he started off westward in hopes of exploring some new country in the Tibetan province of Pomed. Unfortunately, the desultory warfare which had been going on for some years between the Chinese and the Tibetans had at the moment become more active. A Chinese advance westwards was expected, and the Tibetans had the most rigorous orders to prevent any stranger crossing the Salween at Menkong. Unable to prosecute his journey in this direction the traveller turned south down the Salween, hoping to be able to turn west again from Tra-mu-tang to Hkamti on the Upper Irrawaddy. Here again fortune was against him. The Lisu porters, with whose aid he hoped to get as far as the Taron, received orders from the Tibetan official of Tra-mu-tang that they were not to accompany him, orders which may have had their origin in the news that had come through that British troops from Burma were advancing on Hkamti. The winter too had well set in: it was the middle of December and there was much snow on the passes. Though it might have been possible to reach the Taron, the carriers would probably not have been

able to get back to their homes till the summer. In fact, circumstances were too strong, and Captain Kingdon Ward had reluctantly to turn eastwards again and find his way back to Burma through Yün-nan.

It is satisfactory to know, though the author does not mention it here, that he was able, in the following year, to carry through successfully this journey to Hkamti. The author's botanical observations are naturally of much importance, and some remarks on pp. 91–95 as to the extravagant number of seeds required by some plants to enable them to survive in the struggle for existence are of special interest.

Many valuable observations are made on the different tribes, and an important point is mentioned on p. 178, where attention is drawn to the influence that slave-raiding and slave-dealing have had on forming racial mixtures.

Captain Kingdon Ward has wisely adhered to Wade's well-tried system in the transliteration of Chinese names, and has done good service in giving the Tibetan characters for some of the Tibetan names. A slip of the pen occurs on p. 311, where the Shweli is made to run into the Salween. But the only real fault that can be found with the book is the inadequacy of the map. The journey up to Atuntze is for the most part over well-known routes and is not described in detail. For this therefore the map at the end of the book is sufficient. But the little map at the beginning is not full enough, and the reader wishing to follow some of the author's journeys from Atuntze will find that he cannot do so.

Prof. Gregory and his son Mr. C. J. Gregory may be congratulated on doing a very fine piece of work in what must have been a regular race against time. It is apparent all through the book that they were working at high pressure, unable to spare more than the minimum time necessary for the performance of their task, and it is easy to imagine the anxiety that straying mules and lazy carriers must sometimes have caused them. A total of 1500 miles in four months may not seem much in some countries, but in the most mountainous province of China and at a bad season of the year for travelling it is a good performance. Prof. Gregory lets us into the secret of his age, and it may be said that many a man of half his years might envy his physical and mental energy.

The object of the journey and the conclusions arrived at are very clearly stated in chapters i. and xx. Put very shortly, the problem was whether the comparatively modern Himalayan System continued eastward through Tibet and Western China or whether it was blocked here by an older geological formation. The conclusion the authors have come to is that this system does continue into Western China, and that its most probable further extension is along the mountain chain between the Yangtze and the West river.

The greater part of the book is a straightforward account of travel written by travellers who make up for want of previous experiences of China by the gift of shrewd observation and a pleasant style which will make this volume a welcome addition to the books already written on Yün-nan. Not much new country was seen, but north of Yün-Lung the authors had the satisfaction of travelling along a hitherto unsurveyed route. Curiously enough they on p. 229 and Kingdon Ward on pp. 32, 33 of his book both give opinions as to the accuracy or otherwise of the existing maps, and come to opposite conclusions as to whether a certain stream runs into the Yangtze or the Mekong. The War Office map has been cautious enough to give the lower course of this stream in dotted lines.

The map accompanying this volume is adequate, and the routes of the travellers can be easily followed. The use of the Postal Guide in transliteration

has the inevitable result that the bigger places are spelled on one system and the smaller places on another. To this is perhaps due the fact that several names are spelled differently in the text and in the map. The map was prepared to illustrate a paper in this *Journal*, and the smaller names on it were assimilated to the Postal Guide system.

The chapter on "The People of Chinese Tibet and its Borderlands" does not perhaps contain much that is new, but it is all to the good that the authors have found time, with their numerous other duties, to take an interest in this subject. They report the presence of Shans in two places (pp. 150, 151, 235) where they do not seem to have been noticed before, and also the interesting fact that they have here become Buddhists of the Tibetan type. They consider that there is no trace of Caucasian blood in the Northern Lolo or Tibetans, thus differing from Kingdon Ward (p. 129) and several other travellers, who think that, though there is no tribe of pure Caucasian strain, men are occasionally met with who are not pure Mongolians. The man in the photograph in Kingdon Ward's book facing p. 128 and possibly the right-hand figure facing p. 225 may be taken as instances.

The authors naturally had no time to become acquainted with any of the languages spoken and have fallen into a few errors. Their translations of Chinese names are not always to be relied on, and some mistakes occur on p. 66. They do not realize that the order of the words is different in Shan and Siamese from that of the other languages discussed, and that therefore the second syllable of "Mekong" does not mean "river," but is the name of the river. "Hka" is Kachin, not Burmese. It is true that "kiang" does not seem to be much used in Northern China, but "ho" is widely used in many provinces of Southern China, and the crossing of a river called the Ho-wan Ho can in no way be taken as an indication of entering territory "occupied by people of the Northern or Tibetan group."

These are small matters to criticize and do not detract from the value of this book to the traveller or from its importance to the geologist. H. R. DAVIES.

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## REVIEWS

### EUROPE

**Place-names of Skye and Adjacent Islands, with Lore, Mythical, Traditional, and Historical.**— With Index. **Alexander Robert Forbes.** Paisley: Alexander Gordon, Ltd. 1923. 8½×5½, pp. 496. 30*s. net.*

THIS book is a valuable collection of place-names, many of which have not been recorded before. It reflects the highest credit upon the industry and devotion of the author, and it is obviously a labour of love. But our faith in the author's interpretations is shaken by some of those given. The importance of early forms is rightly emphasized in the preface; whether the rarity of them in the book itself is always due to lack of early documents or not, we cannot say; in a large number of instances it undoubtedly is. But in the case of Troterness "upwards of thirty forms from 1507 onwards are omitted for the sake of brevity"; though room is found (on p. 139) for a rhyme of fifty-nine words on the Coolins, and much else that could well have been spared. The author's references to antiquities show that he is not familiar with the writings of scientific archæologists, and we regret to find him speaking constantly of "Druidical" remains. Nevertheless these shortcomings do not prevent us from congratulating Mr. Forbes upon a book which was well worth publishing.

O. G. S. C.

**The Nations of To-day. Italy.**— Edited by **John Buchan.** London: Hodder & Stoughton, Ltd. 1923. 9 × 6, pp. xvi. + 320. *Maps.* 15*s. net.*

In his general preface to this series, Mr. Buchan sets down clearly several reasons for the study of history, particularly at this present juncture. Both at home and abroad what is required in his view is the realization of the complexity of society, the real significance, and danger, of catch-words, and a balanced outlook on the problems of the times. From the history of Italy, much support can be drawn for these views. Her present condition and difficulties have their roots deep in the past. Italy is also a further test of Mr. Buchan's conception of history. He condemns older historians for their devotion to monarchs, generals, and judges rather than to the people generally. Yet this volume shows how difficult it is to avoid such a tendency, for its pages are sown thickly with names of popes, emperors, grand dukes, and all manner of potentates, great and small. Even in the account of the Renaissance period, when less exalted but more remarkable people might be expected to appear upon the scene, it is the rulers who continue to hold the stage, while the scholars, artists, and common people hover in the background. This is, of course, largely due to restrictions of space, and the chapter devoted to the Social Movement, 1860–1915, is an attempt to remedy this shortcoming. The value of an attempt to condense the history of more than ten centuries into six pages is also doubtful. All these objections, however, are common to such series as this. Within these limits it is a competent piece of work. A few pages are given to the geographical factors of Italian history, and the economic situation is discussed at greater length by Mr. A. Cassuto of the *Secolo*. While the "risorgimento" rightly occupies a prominent place in the text, it is somewhat strange that Mr. G. M. Trevelyan's name is omitted from the bibliography.

**From a Terrace in Prague.**— **Lieut.-Col. B. G. Baker, D.S.O.** London: Allen & Unwin. 1923. 9 × 5½, pp. 262. *Illustrations and Map.* 16*s. net.*

Lieut.-Colonel Baker has written a vivid impressionist sketch of the old city of Prague, the capital of the new Republic of Czecho-Slovakia. Taking a vantage-point on a terrace in Prague, the author sees the pageant of Bohemia's ancient capital pass before him. His historical remarks, his topographical descriptions, and his sketches from the daily life of the people of Prague, could have come only from one who had entered very fully into the life of the country and people he describes.

The book, which is illustrated by the author with water-colour and line drawings, makes no pretension to profound learning. It might be considered as a clever guide-book, where the personal impressions and the familiar language of the author take the place of the dry enumeration of names, dates, and figures that one finds in the ordinary Baedeker or Blue Guides. But it is full of useful information, with the drier detail relieved by touches of humour on the character and life of the Bohemian nation. T. G.

**The Nations of To-day. France.**— By various authors under the general direction of **Major-General Lord Edward Gleichen.** London: Hodder & Stoughton. 1923. 9 × 6, pp. ix., 299. *Four coloured Maps and four in black and white.* 15*s. net.*

This is one of The Nations of To-day series prepared under the general editorship of Mr. John Buchan. The longest sections by individual authors are those on French history; that on the period from Charlemagne down to

1871 by Arthur Hassell, M.A., Student and Tutor of Christ Church, Oxford; and that on the Third Republic by the late J. R. Moreton Macdonald, of Largie. Some of the shorter sections however are peculiarly interesting and suggestive, as the preface on Twenty Centuries of French History by André Tardieu, at one time a member of the Cabinet of M. Clemenceau; that on the Land of France by Hilaire Belloc (to which we shall return); and that on French Civilization and Character by Stephen Gwynn. The composite authorship of the volume gives us the advantage of getting somewhat different points of view in different parts of the text. Thus on p. 21 we have Hilaire Belloc telling us that "the rivers of Gaul and of its neighbourhood have never acted as boundaries," while on p. 8 we have M. Tardieu referring to victory as having healed the cruellest of French sorrows through the rewelding of national unity in making good the dismemberment of 1871. The main body of the text is followed by Chronological Tables of French history from 800 to 1922, and two sections printed in smaller type on France's Economic and Financial Position by Etienne Clémental, another minister of Clémenceau's Government, and in this section attention may be drawn to the table on p. 268 showing the amount of agricultural production in 1918 as compared with 1913, and giving striking confirmation of what is stated in the text (p. 233) by Mr. George Adam, a former correspondent of the *Times* in Paris, of the disastrous effect of the war on French agriculture, in spite of which, however, M. Clémental takes a hopeful view of the prospects of the French peasant proprietor. Hilaire Belloc's brief chapter already referred to is naturally that of most interest for the geographer, and it should be noted that, though it bears the title above given, it might have been more appropriately entitled "The Land of the French People." No geographer will quarrel with Mr. Belloc's opening statement that "a nation, being composed of men, is made by the characters of those men. Physical conditions are but limiting and directing agencies. They do not make." Accordingly, when he goes on to deal with his subject in detail it is in his own words "the geographical boundaries of the French people or Gauls" that he gives, describing them justifiably as "peculiarly sharp," but these sharp boundaries are represented as having on the east "for the first hundred miles or so the wooded crest of the Vosges." It is unquestionably with this idea in his mind that he makes the statement above quoted as to "the rivers of Gaul and its neighbourhood," for, he points out, the "German national type occupies both banks of the Rhine and has occupied them from the beginning of history." Another section affording much geographical interest is that written with admirable lucidity by Major-General Sir Frederick Maurice on Military Operations in the War of 1914–18. On another occasion Sir Frederick has been among those who assure us that "if you wish for peace you must prepare for peace," but the reader of the volume now reviewed can hardly avoid the reflection of how much easier it is to prepare for war. G. G. C.

**Spain in Silhouette.— Trowbridge Hall.** New York: Macmillan Company. 1923. 8×5½, pp. viii.+351. *Illustrations and Map.* 14*s. net.*

This record of a journey through Spain two years ago is written in a very free, almost "gushing," style. The author's method is to attach to every spot visited as many historical, artistic, and literary references as possible. Thus, of the Moorish relics of the battle of Los Navas de Tolosa he writes: "The very sight of these brings to the ear attuned to fanciful history the cries of Allah, the bugle blare of the Christian warriors," and so on. By this method

descriptions of a Roman gladiatorial contest at Tarragona and an Auto da Fé at Valladolid are mingled with first-hand accounts of the inevitable bull fight, Holy Week at Seville, and a royal polo match in Madrid. This method has a certain fascination: Spain, with her past glories, lends herself to such treatment, and the writer's seeming omniscience is overawing, but it is apt to become wearisome. Incidentally, the statement that the population of Tarragona in Roman times was two millions is surely a slip. Of modern Spain, one draws the conventional impression from this book of the pride and prejudices of the people, the corruptness of the political circle, and the popularity of the King.

## ASIA

**Seaports of the Far East.**— Compiled and edited by **Allister Macmillan.** London: W. H. & L. Collingridge. 1923. 11×8½, pp. 528. *Illustrations and a Map.*

The purpose of this comprehensive and monumental work is, as the editor and compiler states in his preface, "to convey, by photographic reproductions as well as by descriptive letterpress, useful and interesting information regarding some of the principal seaports of the Far East, more especially their commercial and industrial activities."

Mr. Macmillan begins by giving a general survey of the Far East, with what he considers to be its geographical boundaries; then, after describing its great natural resources and its promise of future trade, he goes on to consider in great detail the ports he has selected for his purpose. These are Rangoon, Bangkok, Singapore, Penang, Hongkong, and Shanghai. Here his method is, very properly, again to describe the general before he approaches the particular, and he gives an admirable summary—historical, descriptive and commercial—of Burma, Siam, and the Malay Peninsula before passing to the analysis of the chief port of each. The section which deals with Siam is particularly interesting. Beginning with an excellent topographical description of the country, he passes to a brief historical sketch, which he follows by an account of the people—their characteristics, dress, religion and mode of life—the Royal Family, the Government, the army and navy, education, medical services, sport, and the great industries of the country, rice planting and the working of teak, ending with a note on mining, railways, general trade, and currency.

It will be seen, therefore, that his method is comprehensive, but it is even more comprehensive when he comes to deal with the seaports themselves. He appears to have neglected no source of information, but he writes clearly, interestingly, and discriminatingly. When, for instance, he describes Bangkok as "just about the worst site for a city that we have ever seen," being built on an alluvial mud flat with practically no fall for drainage, he pays a tribute to the work the medical authorities have accomplished, encouraged by the help of the Rockefeller Institute.

The main object of the work is, however, commercial. Details are given of the chief business firms in each port with an account of their foundation, history, present activities, capital, and agents, thus presenting in convenient form much valuable information not readily available elsewhere.

The numerous photographs which illustrate the book are excellent; there is a good map in colour, and an adequate and well-arranged index. The compilation of such a work as this is a formidable undertaking. Mr. Macmillan deserves great credit for the success with which he has accomplished it, and the publishers no less credit for the admirable manner in which it has been

produced. It is to be hoped that it may be possible to include in a future volume not only an account of the Japanese seaports, as he suggests, but one that would embrace Cochin-China, Borneo, and the Dutch East Indies.

O. R.

**Kings of Arabia.— H. F. Jacob.** London: Mills & Boon. 1923. 8½ × 5½, pp. 294. *Illustrations.* 12*s.* 6*d. net.*

There is not much for the geographer in this rather fortuitous assemblage of papers by one who has known, loved, and courted the Yemen more than most. But he is a very jealous lover—perhaps, too, a very discreet "Political." We had hoped for much supplement of Wyman Bury in that fascinating field, the Aden Hinterland; but all that Col. Jacob vouchsafes amounts to a page or two in the fifth chapter, dealing with our temporary occupation of Dala. We had hoped for a description of the Yemen foothills and folk from one who spent four months in by no means close, though somewhat inglorious, detention at Bajil; but this South Arabian expert, master of the vernacular and student of Arab literature (though not, to judge from his Bibliography, of modern literature about the Yemen from Carsten Niebuhr onwards), sets down nothing about those matters, and indeed little else which the rawest member of his staff could not have told us. Most of the other chapters read like preliminary sketches or arrested growths. The author seems to have thought at one moment of a biography of Haines, the man who took Aden; at others of "Recollections of a Political," of a History of Aden, of a History of the Imamate and the Turks. But he has realized none of these things, but just jotted down a note here on politics, there on customs, there on tribes, writing to please himself alone in frank contempt of any reader's demand for argument and proof. So say I and I ought to know—this is the author's attitude. We grant that he ought, indeed; but few men get blank cheques from their readers. If the Imam Yahya is so great an Arab (he is the only "King of Arabia," except perhaps the late Idrisi, who appears to justify the book's title), we ask why? Pity that the Kuhra tribesmen had so much the courage of their own or the Idrisi's Shafeite opinions that they arrested Colonel Jacob in 1919, for he had never met his great Arab, and is therefore the less able to convince us of his estimate than those who have "run" his rivals. Feisal and Ibn Saud. But some geography there is in the last chapter which deals with Sokotra, and the last but one which deals with Aden, as well as the little in the Dala chapter. On occasion, Colonel Jacob can give rein to an instinct for scientific survey and an interest in ethnology. But he has not taken very many occasions, and about those that he has taken mostly keeps his own counsel. The wilful desultoriness of his *obiter dicta*, and the lack of any *callidus ordo* (he loves Latin tags!) make his book hard to read consecutively; but the student of South Arabian politics and ethnology will find it worth his while to take some trouble.

D. G. H.

**Island-India.— Augusta de Witt.** With an Introduction by **Emily James Putnam.** New Haven: Yale University Press; London: Humphrey Milford. 1923. 10½ × 7½, pp. xv. + 105. *Illustrations.* 14*s. net.*

Although the five stories of which this book is composed make no contribution to geographical knowledge of the Netherlands Indies, they have considerable value as a psychological study of the natives who inhabit the islands, and are at the same time full of interesting details of local customs and beliefs. Miss de Witt was born in the islands, her father being a Dutch colonial official, and her writing is the outcome of keen observation of native ways and of true

perception of native character and point of view, only too often misunderstood by Europeans. The stories require patient reading, for Miss de Witt has packed into them enough material for half a dozen books, and they will admittedly be of most interest to those who know the lands of which she writes; moreover, English readers may be irritated by her curious spelling—not wholly Dutch—of Malay words. Nevertheless, she has the power of re-creating atmosphere in a remarkable degree; she writes from the angle of the native mind, and no one could read her study 'A Native of Java' without catching some of her feeling for the people whom she has obviously come to love. O. R.

**Siam.**— **Pierre Loti.** Translated from the French by **W. P. Baines.** London: T. Werner Laurie & Co. 1923. 9×5½, pp. xi. + 182. *Illustrations.* 10*s.* 6*d. net.*

In taking up this book the first feeling of the reader will be one of surprise that Loti ever wrote a book entitled 'Siam.' A glance at the pages will, however, reassure him that this is 'Un Pèlerin d'Angkor' reproduced, for reasons apparently best known to the publisher, under a new name. Apart from anything else, the selection of such a title is apt to be misleading, for although the ruins of Angkor, at the time of Loti's visit in 1901, were in Siam, the territory in which they stand was shortly afterwards ceded to the French Government, and became part of Cambodia.

Beyond this criticism, however, there can be nothing but praise for the manner in which the book, one of a uniform edition of Loti's works, has been produced. Loti's account of his pilgrimage from Saigon to those colossal ruins that, hidden for centuries in the depths of the forest, made so great an impression upon his sensitive and sympathetic temperament, is illustrated by some magnificent photographs of Angkor-Thom and Angkor-Vat, with a frontispiece in colour by Miss Edith M. Hinchley, while Mr. Baines's translation does much to convey the imaginative beauty of the original prose.

O. R.

**Men of the Inner Jungle.**— **W. F. Alder.** London: Leonard Parsons. 1923. 7½ × 5, pp. x. + 296. *Illustrations.* 10*s.* 6*d. net.*

This book, which was written for the American public, is described by the author as the "narrative of a ramble among the genial Head-hunters." So long as he does not expect anything more than this the reader will not be disappointed, although it is as well to point out that the natives among whom Mr. W. F. Alder spent some time on the Barito river, in Dutch Borneo, have now abandoned head-hunting. Nor is there much evidence of the "daring adventure" and "amazing facts" referred to on the jacket of the book, for the villages visited were well within the Dutch sphere of influence. Mr. Alder, in fact, during his brief sojourn in the island, did nothing more than the ordinary outstation-officer does every day of his life for years on end. This does not mean, however, that interest is absent. Once the English reader becomes used to Mr. Alder "hiking" and to native warriors being "all dolled up," he will find the narrative entertaining enough, for there is much first-hand information about the customs and home-life of a primitive and likeable people who have obviously won the author's sympathy and affection. The book has no map but contains a number of excellent photographs taken by the author.

O. R.

AFRICA

**In Witch-Bound Africa: An Account of the Primitive Kaonde Tribe and their Beliefs.— Frank H. Melland.** London: Seeley, Service & Co. 1923. 9 × 5½, pp. 316. *Illustrations and Maps.* 21*s. net.*

The account of the Bakaone given by Mr. Frank Melland is of much value. It may indeed be called an indispensable book for the professed ethnologist whose particular study is the Bantu peoples. It makes, however, a wider appeal; the book is so written that the general reader will not be puzzled by the use of technical terms. He will, in fact, find Mr. Melland's record fascinating. It illuminates for us the ways and thoughts of the black man more clearly than most books of its kind. And the reader has this assurance, that the author is absolutely trustworthy—nothing is set down which is not the result of most patient investigation, checked, wherever possible, by the researches of other Europeans and the information of many native helpers.

The Bakaone live in the Kasempa district of Northern Rhodesia; in which district Mr. Melland spent eleven years. He begins, rightly, with a description of this region, which lies immediately north of Barotseland, and in which is the source of the Zambezi. Though it is known in broad outline, we are grateful to the author for his account of Kasempa—it helps us to understand how geographical conditions tend to mould the character of a people. This description of the land is followed by a chapter on the history of the Bakaone, and then Mr. Melland gives us in detail the life-story of the tribe, from birth to death—and after death. Much space is devoted to religion, witchcraft, divination, charms and talismans. On all these, and other subjects, there is much to be learnt, and to the book itself the reader is referred. Attention must however be called especially to Mr. Melland's final chapter "The Future of the Natives." It is full of wholesome, if somewhat bitter, truths—*e.g.* "Law, order and discipline are not progress"; "Our habit of treating the native as a commodity at the disposal of the white"; "Witchcraft is *not* a part of native religion"; "I have never met any heathen in Africa (except for a few civilization-spoilt individuals)." This chapter should have the earnest consideration of all administrators and missionaries, and of every one who really desires the welfare of the black races. F. R. C.

**Le Désert Oriental Egyptien. Du Nil à la Mer Rouge.— Jean Raimondi.** (Mémoires de la Société Royale de Géographie d'Egypt, T. IV.) Cairo: 1923. 14½ × 11, pp. viii. + 96. *Maps, Illustrations, and Diagrams.*

The geographer who turns to this memoir for the latest account of the Eastern Desert of Egypt will be disappointed, for it consists mostly of accounts of the railway reconnaissances from Qena to Qosseir, and from Kom Ombo to Ras Benas, which were carried out in 1891 and 1897 by members of the staff of the Egyptian Railway Administration. From the nature of the work there is little information about the desert generally, but only such as relates to the route selected as being the most practicable for a railway, and to the needs and possibilities of a port and terminus on the Red Sea coast.

A report of the Mines and Quarries Department on the Mining Industry of Egypt (1922) is quoted for the account of various minerals which have been obtained in Egypt during the past fifteen years, but with this exception there is no reference to the large amount of geographical and geological work which has been carried out in the Eastern Desert during the last twenty-seven years, and which has furnished us with very fairly adequate maps and descriptions of it from north to south.

The Memoir commences with a reference to the general economic situation under post-war conditions, and passes to a brief account of those which prevailed in Egypt prior to the construction of the Aswan Dam and the various barrages which were part of the general scheme for introducing perennial irrigation into Middle Egypt. A short account of the mineral resources of Egypt serves to introduce the reader to the detailed descriptions of the two routes which were reconnoitred in the last decade of the nineteenth century as parts of a scheme for linking up the Nile Valley with the Red Sea. Neither of them was ever constructed, and in the Memoir there is little to encourage the hope that they may be in the future. A report by M. Prompt in 1890 urging the advantages of extending the Egyptian railway system, which at that time only reached as far as Girga, to Khartoum, is printed as an appendix.

The Memoir is well printed, and contains a number of plans, some of which appeared in the reports of the Railway Administration at the time.

H. G. L.

**The Problem of the Obelisk.— R. Engelbach.** London: Fisher Unwin. 1923. 9 × 5½, pp. 134. *Illustrations.* 9*s. net.*

This little book treats of the great Egyptian monoliths, not from an archæological but from a mechanical and engineering point of view. It is concerned with their extraction from the quarry, their transport, and erection. The subject however is interesting to European prehistoric archæologists whose minds have long been vexed, and their ingenuity exercised, in trying to explain how the great megaliths of western Europe, as *e.g.* the great menhir at Locmarisquer, and the covering stones of the largest dolmens, were raised and put in place. The method adopted by the Egyptians in erecting the obelisks is unknown. The author gives an account of the different theories that have been advanced on the subject, and explains at length how he imagines the deed was done. It is a matter of unceasing wonder how the Egyptians were able to erect the largest obelisk, without any of the mechanical devices available to the engineer of to-day, as *e.g.* the jack, the capstan, and probably even the pulley: all the more so if, as the author asserts, it would probably be impossible to erect the largest obelisks to-day with modern devices. The work concludes with a chapter on the Egyptian obelisks that have fallen into the hands of the vandals, and by them been transported to the ends of the Earth, New York, Rome, Paris, London. Some of them are known by the familiar name of Cleopatra's Needle, notably that on the Thames Embankment, an absurd title, considering that it was made nearly 1500 years before the time of the celebrated Egyptian queen.

E. A. P.

## AUSTRALASIA AND PACIFIC ISLANDS

**Willis Island: a Storm-warning Station in the Coral Sea.— Captain John King Davis,** Director of Navigation for the Commonwealth of Australia. With an Introductory Chapter by Prof. Griffith Taylor. Melbourne: Critchley Parker; London: Effingham Wilson. 1923. 8½ × 5½, pp. 119. 37 *Photographs and* 12 *Maps and Line Drawings.* 15*s. net.*

The Willis Group consists of three islets nearly in line north-east and south-west, rising from a bank, some 13 miles long and 5 miles wide, in the midst of the Coral Sea, and 250 miles from the coast of Queensland. They were previously known as South Islet, Mid Islet, and North Cay, but South Islet, which is higher and larger than the other two, is now called Willis Island. Its formation is a central sandheap, 468 yards long and 150 yards wide, which is covered with grass or flowering plants, surrounded by a coral beach. The beach adds con-

siderably to the area of the island, making the length 583 yards and the greatest width 212 yards, but, being swept by the sea during gales, it shifts its position, and cannot therefore be regarded as terra firma. On the grassed portion of the island, however, no evidence of inundation has been found.

The island is admirably placed to gather storm warnings during the "Hurricane Season," which extends in the Coral Sea from the middle of December to the end of March, January being the worst month. These storms, which cause havoc both on land and sea, travel about 100 miles an hour and apearp to originate between 8° and 10° of S. lat., and then travel approximately south-west. Between 15° and 24° S., they nearly all curve in a parabolic path, and then proceed south-east. The establishment of a wireless storm-warning station on the island had long been advocated, on the ground that its daily report of the weather conditions prevailing in the vicinity would be of the greatest value to coastal stations on the mainland in supplying additional information for the preparation of forecasts, and in rendering the storm warnings issued to vessels more accurate.

Grave doubts were expressed as to the safety of any party left on the island during the hurricane season, but Captain John King Davis, who commanded the *Aurora* during the Australasian Antarctic Expedition, volunteered to establish the station and to remain on the island during the bad weather season, and his offer was accepted by the Cabinet. On 1 October 1921 he sailed from Melbourne with a party of fourteen, which included a clerk of works, a wireless mechanic, two wireless operators, and ten carpenters and labourers. They reached Willis Island on October 15, and at once set about building the station, with such success that the first mast was erected on October 31 and communication established with the mainland the following day. On November 7 the Commonwealth flag was hoisted over the wireless hut, and formal possession of Willis Island and the adjacent islets was taken, there having been no previous annexation.

Captain Davis remained on the island without mishap until relieved on 16 April 1922. Although no hurricane actually visited Queensland during the period, he was able to give the first warnings of several tropical cyclones, and so clearly demonstrated the value of the meteorological station that the Federal Government definitely decided to place it on a permanent basis. His straightforward and interesting account of his sojourn on the island is enriched with valuable notes on bird and plant life and with tables of meteorological observations.

O. R.

## HUMAN GEOGRAPHY

**The Children of the Sun: an Enquiry into the Early History of Civilization.— W. J. Perry.** London: Methuen & Co. 1923. 9×5½, pp. xiv. + 551. 16 *Maps.* 18*s. net.*

That the first great step in Social Evolution is from food-gathering to food-producing can hardly be gainsaid, for with the knowledge and practice of agriculture civilization may be said to begin. What were the characteristics of the civilization the first food-producers evolved? Where did this archaic civilization originate? Where elsewhere in the world is there evidence of its existence? What were the causes of its extension into these regions? These are the problems discussed in this work. According to the author the archaic civilization originated in Egypt, and spread thence to India, Indonesia, Oceania, ultimately reaching America. Among the characteristics of this civilization were the use of irrigation for agriculture, the raising of megaliths such as pyramids, dolmens, and stone circles, the use of polished stone implements,

the making of pottery, mining and pearl fishing, Sun worship, and mummification; and, on which much stress is laid and which is treated at great length, a dual organization, and the existence of a ruling class in two divisions: (1) the Children of the Sun, connected with the sky, and born of theoganies; (2) rulers associated with the underworld who survive as war chiefs.

In a series of maps the distribution of this archaic civilization and certain of its characteristics are brought out. These do not show a continuous line. Far from it; there are many gaps. It is only here and there along the specified region that evidence, and that often slight, is discoverable. Why is this? Here comes in a fundamental point in the author's theory, and one of interest in its bearing on the spread, maintenance and decay of civilizing influences, especially in view of the theories now so dominant among geographers regarding the influence of climate on civilization. Climate had little or nothing to do with the spread of this civilization. The animating motive was the search for valuables, notably gold and pearls, and the author strives to show that wherever this civilization was prominent, there valuable minerals or pearls are or were found. He has little difficulty in finding modern examples of similar motives causing a large population with the adjuncts of civilization to settle in regions climatically adverse, as *e.g.* the Yukon and Western Australian goldfields. Mr. Perry often supports his arguments by a clever use of tradition. "In this inquiry," he says, "much reliance will be laid on traditions: they will not be looked upon as products of imagination, or necessarily as attempts to explain ritual, but as something ranking as fact, to be studied as such."

The supreme test of his theory is America. In attributing the Maya culture to the archaic civilization reaching the New World by way of the Pacific, he is advocating views that only a few years ago were treated with derisive contempt, and to-day are regarded with disdain by certain authorities in America. Mr. Perry has the courage of his convictions, and carries the war with vigour into the enemy's camp. Arguing his case with much ingenuity he shows the inadequacy of Prof. Huntington's contention that climatic changes account for the facts of the Maya civilization, and in reply to Messrs. Morley and Spinden, who speak of the views he advocates as extravagant hypotheses, scarcely meriting even passing notice, he says, "in spite of wholesale condemnation of their opponents, they are unable to produce a single fact in favour of its indigenous origin." Indeed, no evidence whatever exists at present pointing to the origin of Maya civilization in America. What has always appeared so mysterious is the fact that, so far as America is concerned, it seems to have sprung full blown from the ground.

Such in merest outline is the author's thesis. That there are weak links in his chain of argument he would doubtless admit. But that he has written a book deserving of careful study there can be no doubt. It is to be feared that its length, more than five hundred closely printed pages, may deter some from tackling it. But it will be worth while to do so, and justice cannot be done to the author's views unless all the evidence he adduces and marshals is studied.

The student of anthropology has been treated to such a surfeit of collections of specimens and facts—anatomical, archæological and ethnological—that he is liable to feel overwhelmed. The time has come for more synthetical research, for greater effort to interpret, and search out the meaning and significance of these innumerable details. As a bold and carefully reasoned effort in this direction Mr. Perry's work should be welcomed by all unbiassed students of the Science of Man. The list of authorities at the end of the book should serve as a useful bibliography. E. A. P.

GENERAL

**Practical Plant Ecology.— A. G. Tansley, F.R.S.** London: G. Allen & Unwin, Ltd. 1923. 7½×5, pp. 228. *Illustrations.* *7s. 6d. net.*

The author aims to provide a guide for beginners in the field study of plant communities, and in so doing has produced a book for which there was a real want. After a discussion of the scope of ecology he gives an account of the units of vegetation, the succession of vegetation, and an outline of British plant communities. Practical directions are then given for the study of vegetation, after which various environmental factors are considered. A concluding section deals with ecological work in schools. Mr. Tansley pleads, we feel with much justification, that some teaching in biology should be continued throughout the school career. He is willing to admit the larger claims of chemistry and physics after perhaps sixteen, but cannot accept these branches of study as a wholly satisfactory scientific training. He believes that, at least in country schools, ecology should supply this biological study. It would certainly be far more educative and more truly scientific than mere floristic work. The spread of interest in plant ecology is a welcome aspect of modern botany. It does for the plant world what the modern geographer is attempting for the human world, and the essentials of plant ecology are a necessary part of geographical study. The volume deserves wide attention, and not least so because it dwells on the necessity of field work. R. N. R. B.

**Into the Frozen South.— Scout Marr.** London: Cassell & Co. 1923. 8×5½, pp. x.+246. *Illustrations.* *6s. net.*

The scout who accompanied the *Quest* on her voyage to South Georgia and the Antarctic icepack has written an account of his experiences and impressions. The narrative should appeal to boys, for whom no doubt it is written, for it dwells on the adventurous side of the cruise, and contains little or no mention of the scientific objectives of the expedition. The author evidently enjoyed his voyage, even if he is apt to describe many of the scenes in somewhat gloomy tones; but the *Quest* must have been a trying vessel for navigation in the South Atlantic. The illustrations are good, but the lack of a map is a serious defect. R. N. R. B.

**The Story of my Life.— Sir Harry H. Johnston, G.C.M.G., K.C.B.** London: Chatto & Windus. 1923. 8vo. Pp. 536. *21s. net.*

Sir Harry Johnston's career in the public service was long and diversified, and highly successful in most respects, though often at the expense of health. He has helped to acquire and has governed new territories, discovered new beasts, written valuable books of travel, and created a new genus of fiction. His artistic ambitions took him into the Royal Academy Schools at the age of sixteen, and he gained early in life a colloquial knowledge of modern languages, European and Eastern, which served him well, and on whose importance he rather insists, in disfavour of academic studies. His passion for natural history diversified his official duties abroad, enlivened and beautified his books of travel, and a little embittered his estimate of museums. An enthusiasm for the infinite variety of Bantu speech, coupled with immense industry and a keen eye for unexpected opportunity (as among the French Senegalese troops brought to Europe by the war) provided the most enduring interest and the most permanent achievement of his extra-official activities. Courage and self-confidence in dangerous situations; a measure of contempt for officials at home who could not always move as fast as he wished; social gifts and unique knowledge

which gave him direct access to the supreme authorities in England and on the Continent; a keen eye for eccentricities and a little taste for scandal sometimes indiscreetly retailed;—all these and a hundred more facets of a many-sided character are displayed in the autobiography just published.

Sir Harry Johnston had so considerable a part in the rather scrambling performance staged in Africa between 1880 and 1905 that all students of political geography will enjoy the book, and will find in it a great deal more than they might expect from the title, for the autobiography lapses often into history, eminently readable if occasionally one-sided. No two actors in the Partition of Africa can have the same view of the confused events from which the pre-war situation emerged about 1905, and this volume contains material for history that deserves careful weighing. But to our disappointment there is not much geography. The author professes indeed some slight contempt for the efforts that he declares were made by Bates and Coles to turn him into a geographer; and though he became in due time a Gold Medallist of our Society, he has modestly forgotten to mention it. He tells of his first youthful appearance before an evening meeting of the Society in 1884, and how de Lesseps was then on the platform. But he does not relate, and perhaps never heard, what de Lesseps said to an honorary secretary on that occasion: "Mais, Monsieur, quel pays, dans lequel même les petits enfants sont des voyageurs renommés!" From that day forward Sir Harry Johnston made many contributions to our meetings and *Journal*, and served the Society for long as a Councillor and as Vice-President; yet his last reference to the Society is a casual mention of Sir John Keltie as its librarian! It is our duty therefore to assure the many readers of his autobiography that Sir Harry Johnston is a more active and esteemed geographer, and has played a larger part in our affairs, than he is pleased to admit.

**The Last Secrets: the Final Mysteries of Exploration.— John Buchan.** London: T. Nelson & Sons, Ltd. 1923. 7½×5, pp. 303. *Sketch-maps and Illustrations.* 5*s. net.*

The contraction of the limits of the world, and its consequent interdependence, has become of late a common enough theme. The gain in some directions has been accompanied, one can hardly say outweighed, by loss in others. Explorers and adventurers will sigh with Mr. Buchan over that disappearance of "large, bold, and obvious conundrums" which the twentieth century has witnessed. The last secrets, whose unveiling is here recorded, were widely scattered over the globe, and these accounts offer a stimulating range of scenes, trials, and final triumphs. They include the military expedition to Lhasa, Wavell's visit to the Holy City of Islam, the Mount Everest expeditions, and Scott's Antarctic journey. Yet even by the beginning of this century, the great days of exploration had passed: the goal of the explorer had become a forbidden city or a mountain peak. This, however, weighs little with Mr. Buchan when, for example, he writes of the Mount Everest Expedition: "there were many to ask what was the use of such an enterprise . . . The answer is that it was of no earthly use, and that in that lay its supreme merit." As for the future, there will always be scope for research not altogether devoid of romance, and for the free play of imagination, while on the other score we need have no fears—there will never be opportunities lacking for the human race to demonstrate "the capacity of spirit to dominate material."

**Jersey : an Isle of Romance.**— **B. B. Elliott.** Illustrations by H. V. Edge. London : Fisher Unwin. 1923. 8½×5½, pp. 260. *10s. 6d. net.*

**Bermuda, Past and Present.**— **W. B. Hayward.** London : S. Paul & Co. 1923. 7½×5, pp. xii.+238. *Map and Illustrations.* *8s. 6d.*

The aim of the authors of these books is to popularize the two islands as holiday resorts. Miss Elliott, as may be gathered from her title, relies more particularly upon the history and legends of Jersey for her material. Stress is laid upon its *rôle* through the centuries of a " sanctuary," a sanctuary rendered particularly attractive to-day by reason of its climate, historical associations, the quaint customs that have survived there, and not least by its immunity from heavy taxation, arising out of its peculiar relationship to Great Britain. Mr. Hayward's object is more apparent, and the greater part of his book is devoted to urging the attractions of Bermuda as a holiday resort ; the points of interest in the island are fully described, and a chapter deals with the various recreations to be enjoyed. A few " useful facts for the traveller " are also added.

**The Romance of Excavation.**— **David Masters.** London : John Lane. 1923. 7½×5, pp. xiv.+192. 29 *Illustrations.* *6s. 6d. net.*

This book gives one the impression of having been written at a great speed. The chapters lack cohesion and unity, and the writer has a habit of repeatedly going into raptures over the wonders of his subject. This may be caused through anxiety to enable " the reader to capture the thrill of the romance of digging up the world's history," in the publisher's words. Nevertheless, despite the jumble of religion, archæology, geology, and history the book contains, it does serve to give the general reader an idea of the history, results, and present position of archæological excavation in Egypt and the Near East. The work of Schliemann at Troy, of Maspero and Flinders Petrie in Egypt, and of Sir Arthur Evans in Crete, requires no " writing up " to make it enthralling, or even " popular and readable."

**Jorden og Menneskelivet. Geografisk Haandbog.**— **Martin Vahl,** Professor ved Universitetet og **Gudmund Hatt,** Dr. Phil. Förste, Andet Bind. Köbenhavn : J. H. Schultz Forlagsboghandel. 1922–23.

The work, of which the first two volumes have now been issued, will consist of four volumes containing about 2000 pages, and promises to be a very useful and important compendium of geography for those who can read Danish. The first volume comprises sections on general geography—the form and movements of the Earth, land forms, the oceans and atmosphere with their winds and currents, climates, etc. ; while the later chapters deal with the Arctic Ocean and North America. Besides the natural features and their origin, climates, fauna and flora, the activities of the various tribes and peoples are, as indicated in the title, described in considerable detail, with statistics of agricultural crops and industrial products as well as statistics of population. The historical paragraphs are perhaps somewhat too much expanded ; the fortunes of the Hudson Bay Company, the ancient civilization of the Aztecs and Mayas, and the story of the Panama Canal from the first suggestion in 1529, are subjects not strictly geographical.

The second volume, received after this notice was originally written, deals with South America, the Oceans, Australasia, and the Antarctic Continent.

In a work of this size some slight mistakes are inevitable, and in some cases rather fuller detail or clearer explanation is desirable. One error in particular should be noticed : it is stated that Professor Chamberlin propounded the

meteoritic hypothesis in 1906, whereas Norman Lockyer's book on the subject was published in 1890. The section on maps is decidedly defective, only one or two special projections being mentioned, whilst others more commonly used in atlases are passed over. Nor is anything said of survey maps on a large scale, or of contours and other means of indicating the form of the surface and the topography. When the whole work is published it will be easier to form a judgment of its merits.

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## THE MONTHLY RECORD

### EUROPE

**Floods of the Allier.**

THE periodical and marked nature of the floods of the Allier is the subject of a detailed study by M. H. Onde in the *Revue de Géographie Alpine*, tome xi. fasc. ii., 1923. These floods often rise extremely rapidly. For instance, in September 1866, at Langogne, the Allier rose 5·51 metres in thirty hours; in November 1899, at the same point, 3·22 metres in eight hours, while at Condes in 1875 it rose 7 metres in seventeen hours. The Allier is one of the main tributaries of the Loire, and rises in the Cevennes, close to their south-eastern escarpment. On the Mediterranean side, their face is much broken up by the valleys of the streams which flow to the Gulf of Lyons. These breaches in the Cevennes are of considerable importance, as they permit weather systems originating over the Mediterranean to reach the basin of the Allier. In a similar way, the valleys of the Cère, Truyère, and Alagnon breach the western side of the central Massif, and bring the Allier basin under the meteorological influence of the Atlantic and the south-west winds. On the whole, the Central Massif in the region of the upper Allier is composed of impermeable rocks: that is, the impervious rocks coincide with the steeper gradients of the river. These factors all contribute to produce, after heavy rain, an immediate concentration of surface water in the upper channel of the Allier. The fact that the river basin is less forested than the average for France as a whole further contributes to this state of affairs, as the regulating influence of trees is thus less than it is elsewhere.

An analysis of the rainfall of the Allier basin shows that in its course the river flows through three distinct climatic regions. The upper section, approximately the Department of Lozère, experiences its maximum rainfall in spring and autumn, particularly the latter season. The lower section, Department of Puy de Dôme, has its greatest rainfall in summer, while the central is indeterminate. M. Onde distinguishes four main types of exceptional rains which, in conjunction with the physical features noted above, produce rapid rises in the level of the Allier. The first two, "pluies cévenoles et pluies mixtes," occur in connection with easterly or southerly winds blowing across Provence, caused by anticyclonic conditions over eastern Europe. These are equinoxial, and particularly autumnal; the former are localized in the upper Allier, but the "pluies mixtes" are more general, from Langogne to the middle Allier. The third type, the oceanic, accompany the north-westerly or south-westerly winds set up by anticyclonic conditions, especially over Spain. They occur both in winter and summe, most markedly in the middle and lower courses. The special feature of the fourth type, "pluies de temps orageux," is its occurrence in the warm season, as a result of atmospheric instability over the continent. The conflict of these factors causes rises of level to take place very irregularly:

roughly, the autumn is the usual season in the upper river; lower down they are divided between the spring and winter. The apparent paradox that the river is lowest in summer, which is in general the rainy season, is explained by the fact that to produce an equal rise, four times as much rain is required in summer as in winter.

**Industrial Water-power in Piedmont.**

The lack of an adequate internal coal supply has been one of the factors which have retarded the growth of Italian industries. It explains also the attention being paid to hydro-electric works. The present stage in their development is described in detail by A. Sandri in an article, "La distribuzione delle forze idro-elettriche nel Piemonte," contained in the *Rivista Geografica Italiana*, vol. **30**, v.–vii., 1923. In proportion to area, Italy is one of the countries best supplied with water-power, while her physical configuration makes it generally available. Of the total power obtainable, it is calculated that Piedmont possesses about 20 per cent. A study of the hydrology and physical features of the region demonstrates its advantages. The distribution of the rainfall is regular, increasing in quantity as the Alpine barrier is approached. With one exception, the areas of lowest rainfall occur in the middle of the river valleys, particularly where they change direction suddenly, as *e.g.* the Val d'Aosta does at Montjovet. The annual amount of precipitation ranges from 600 mm. on the plains to 1200 mm. on the mountain slopes, while for the high Alps it is estimated in some instances to reach 2–3 m. As regards seasonal distribution, northern and central Italy experience spring and autumn rains, though northwards there is an increasing tendency to approximate to the continental type of summer rainfall, which predominates north of the Alps. A line north and south through Asti separates the region of maximum spring rainfall, the Piedmont, from the Appennine, where the maximum falls in autumn. These considerations bearing on the supply of water are modified by others, such as evaporation, which are less easily measured. Rivers partly fed by glaciers, which occur chiefly in Piedmont, receive a great augmentation in summer, that is, when they would otherwise be at their lowest, as in the Appennine region. The impermeable nature of the rocks and morphological conditions producing waterfalls also give Piedmont considerable advantages. Hydro-electric centres are also largely determined by economic factors, though technical improvements permitting long-distance transmission have modified their influence. In Piedmont the areas of greatest hydro-electrical production coincide with the great industrial centres only in the region lying immediately at the foot of the mountains. Thus Turin is supplied from Bussoleno on the Dora Riparia. In 1918 Piedmont produced the most power, being followed by Lombardy, though the latter region possessed more installations (216 to 90), while in proportion both to area and population Piedmont was also exceeded by the Trentino, among other regions. Development in the Appennine region has been retarded by the scarcity and uncertainty of the water supply, owing to a lower rainfall, less snow, greater evaporation, and the absence of glaciers and lakes. The irregularity of the floods has also made it necessary to construct reservoirs.

The effect of hydro-electric development upon the population of Piedmont is interesting. Between 1881 and 1911 it has checked the tendency to urban concentration: the emigration figures for the mountain districts have also fallen, while the fact that the mountains produce while the plains consume gives a new unity to the whole region.

**Town Planning in Italy.**

The development of the modern science of town planning and its application to Italian cities is discussed by Sig. D. Barbieri in an article entitled " I piani regolatori e la fisonomia della citta," which appears in *Rivista mensile del Touring Club Italiano*, August 1923. The earliest form of a regular town plan developed from the Roman quadrilateral entrenchment. The central square or market-place was an obvious advantage, and in course of time the town extended along the roads radiating from the principal gates in the walls. Characteristic examples of this type are Aosta and Bologna. From this was later evolved the " chess-board " plan of straight roads cutting each other at right angles. The writer points out the disadvantages of this type for traffic, drainage, and canalization, and holds that the attractiveness of cities of this type, for example Turin, is to be explained on other grounds. Other rectilinear schemes are examined: in Philadelphia, for example, great diagonal cross-roads were superimposed upon the system of squares, and in the new quarter of Rome, Piazza d'Armi, two or more centres, already in existence, are linked together by great cross-roads, each with its subsidiary system. The theoretical perfection of this type would be a city with, say, eight main roads radiating from the centre, around which would run, at regular intervals, a series of roads octagonal in plan. But this type is monotonous; and on æsthetic grounds and because of its adaptability to topographic features, the curved line is now preferred for roads. It permits the development of town plans already in existence, and does not hamper traffic. The " organic " side of this science includes the classification and distribution of civic services, residential quarters, and industrial centres; the technical is concerned with the application of engineering and hygienic principles to the soil and climate; while the artistic, which is not only æsthetic but also historical, deals with the preservation of the individual character of the town, as well as its historic buildings. The surroundings of the town must also be taken into account. Examples of this type, such as the new " Citta Giardino Aniene " at Rome, where the winding roads are fitted to the undulating terrain, and dangerous cross-roads and awkward turnings are avoided, compare favourably with others on older lines, *e.g.* the " Quartiere dei Prati di Castello," at Rome, which, though healthy and spacious, lacks character and impressiveness.

## ASIA

**The High Peaks of the Himalaya.**

The Surveyor-General of India calls our attention to a curious oversight made by General Bruce in ' The Assault on Mount Everest, 1922.' Speaking of the first ascent without oxygen to 26,985 feet, General Bruce says: " In the whole range of the mountains of the world there are only four peaks that top this great height, namely, Mount Everest itself, $K_2$ in the Karakorum in Baltistan, Broad Peak on the Baltoro glacier, and Makalu in the Everest group." Kangchenjunga is forgotten!

Colonel Ryder takes the opportunity of sending an interesting note by Colonel Cowie on the height of Broad Peak, which is entered on the Indian triangulation chart as over 28,000 feet: a result taken from the work of the Guillarmod Expedition of 1902. It seems, however, that this must be wrong. The region was visited by the Duke of the Abruzzi's expedition in 1909, and the Marchese Negrotto, R.I.N., made a photogrammetric survey with a triangulation based on points supplied by the Survey of India. The height of

Broad Peak thus found was 27,133 feet, and Colonel Cowie considers that this should be accepted in preference to the greater height.

We may add that the southern peak of Mount Everest, Lhotse, was fixed by Major Wheeler in 1921 at 27,890 feet. As it is 2 miles from the principal summit, and separated from it by a distinct col, it is perhaps entitled to a place of its own in the list of highest peaks; and that place would seem to be fourth, below $K_2$ and the higher peak of Kangchenjunga, but above Makalu and all others. The figure 27,890 is referred to the old height for Mount Everest: 29,002 feet. Both are at least 140 feet low, so that Lhotse should really come into the select group above 28,000 feet.

**River Changes in India.**

The *Scottish Geographical Magazine* for January 1924 contains a paper read to Section E (Geography) of the British Association last year by Mr. W. H. Arden Wood on "Rivers and Man in the Indus–Ganges alluvial plain." It is devoted in the main to an attempt to reconstruct the river systems as they have existed at various times by a study of old river-beds, the sites of deserted cities, and historical records. The plain itself consists either of sand, a stiff clay, or more generally a mixture of both. It slopes almost imperceptibly from the Bay of Bengal on the east and the Arabian Sea on the west, up to the water-parting about 900 feet above sea-level, in the region south of Simla. The constitution of the plain therefore offers no obstacle to the constant changing of the river-beds through exceptional floods, ordinary river erosion, or the work of man. The re-tracing of the beds is sometimes made easier by the fact that the name of a river is not transferred with it to its new course. Sometimes a prefix may be added to show its decay, as in the case of Buddh (old) Ganga, or Adi (original) Ganga.

Human dwellings in India have always followed the courses of the rivers, so that the diverting of a river brings destruction or partial decay to a flourishing city. Ruined cities, forts, and villages thus mark clearly the old river-beds. Historical records are also useful as showing the important cities during a particular epoch. Their sites must first be located, and then related as far as possible to a river system. Unfortunately, most internal historical material prior to the Mohammedan invasions has been destroyed. Some light is provided by the Chinese Buddhist pilgrims, but their use of Chinese units makes accuracy difficult. Kanauj, the seventh-century capital of Northern India, is now a small town on the old high bank of the Ganges. Recent examples of such changes are supplied by the fate of the railway centre of Goalundo, at the junction of the Padma and Brahmaputra. In the rainy season of 1875 the Padma cut inland, establishing itself permanently south of the town, so that this has been re-built on the other side of the river. Cossimbazar is an example of the slower working of similar factors. It was once a flourishing trading centre on a bend of the Bhagirathi, but the bend gradually deepened into a meander, across the neck of which the river eventually cut a fresh bed, so that, deserted by the river, its trade has gone too. The paper concludes with detailed studies of the Ganges delta, the position of Calcutta, and the history of the riverless gap south of Simla which extends south-west into the Indian desert. By tracing out the Hindu "line of sanctity" it is shown that the Hooghly was at one time the main Ganges stream. It is thought that changes in level during the sixteenth century caused the main body of water to break eastwards and occupy the bed of the Padma. The consequent silting up of the Hooghly has been increased by the diversion of the Damodar, which previous

to 1770 flowed into it 39 miles above Calcutta, while it now joins it 35 miles below. The scouring action of the tides assures Calcutta's future as a port, but as a habitable city it is threatened by the silting-up of the Bidyadhari, into which its drainage flows. The "riverless gap" is explained by three sketch-maps showing the Punjab river system at various periods. This area was formerly watered by the great river whose old bed is now known as the Hakra. Once fed in part by the Sutlej and joined by the Indus in Sind before reaching the Rann of Cutch, this river eventually dried up as a result of the gradual westward movement of the whole system, and what was once one of the richest districts in India thus disappeared.

**The Bore of the Tsientang River.**

The phenomenon of the "bore" on the Tsientang Kiang at Hangchow has been described extensively, notably by Captain W. M. Moore and Sir George Darwin. It is of interest to note that its characteristics and cause, and the dependence of the tides upon the moon, were understood by the Chinese as early as the first century A.D. This is shown by an article by the Rev. A. C. Moule in *T'oung Pao*, vol. **22**, No. 3, Juillet 1923, under the title "The Bore on the Ch'ien-T'ang River in China." This consists chiefly of an extract in Chinese, with a translation, from the 'Hsien shun Lin an chih' by Ch'ien Yüeh-yu, which was printed at Hangchow *circa* A.D. 1274. This extract, which is itself based upon older authorities, besides dealing with the "bore," shows that in China, to quote Mr. Moule, "by the middle ages a theory of the tides had been developed which was in advance of anything that seems to have been known at that time in Europe."

## AFRICA

**Completion of the Dakar–Niger Railway.**

Through railway communication between the ocean and the navigable section of the Upper Niger at Kulikoro has at last been provided by the opening, on 31 December 1923, of the Thies–Kayes section of the line, which now has a total length of 810 miles and is the longest in West Africa. By the courtesy of the Department of Overseas trade we have received some particulars of the line, supplied by H.M. Consul-General at Dakar, who was present at the opening ceremony. The provision of such through communication had long been a desideratum with the French Colonial authorities, and the building of the section from Kayes to Bafulabe on the Upper Senegal was one of the earliest achievements in tropical African railway enterprise. The extension to Bamako on the Niger was completed, after long delays, in 1904 (see *Journal*, vol. **24**, p. 482), and supplied communication between the sea and the Upper Niger with the aid of the line from Dakar to St. Louis and the Senegal navigation from St. Louis to Kayes. But, apart from the inconvenience of transhipment, transport was possible only during part of the year, the Senegal being navigable only for a limited period. It is hoped that the continuous communication now provided will do much to further the development of the regions tapped by it. The new section is a single line of metre gauge, the rails being laid on steel sleepers. It crosses two steel bridges 50 metres in length, and one over the Faleme 200 metres long, of which 50 metres are of masonry, the rest of steel girders. Passenger trains are provided with sleeping, restaurant, and corridor carriages of the usual three classes.

**Variations in the Level of Lakes Victoria and Albert in Relation to Sunspot Frequency.**

Lake Victoria, situated on the equator at nearly 4000 feet above the sea, with an area between a third and a half that of England, constitutes the chief supply of the White Nile. It is thus of special hydrological importance, and lake-level gauges have been in operation since 1895. In a recent publication of the Meteorological Office (*Geophysical Memoirs*, No. 20) entitled "Variations in the Levels of the Central African Lakes Victoria and Albert," Mr. C. E. P. Brooks discusses the records for the period 1896–1922 of the gauge established at Kisumu at the head of the Gulf of Kavirondo, on the east side of the lake, which is in every way suitable for observations of level. Monthly observations of maximum and minimum water-level indicate an annual and a sunspot period of variation, and it is suspected that the analysis of curves from an autographic gauge would disclose the existence of more minute fluctuations in the nature of seiches and tides. Morning and evening observations during the last few years also indicate a diurnal variation at Kisumu attributable to lake and land breezes, and the effect would thus be local as between the shores and middle of the lake. The annual variation is a complicated effect of a double rainy season, lag in response to the latter, and evaporation; and it may be noted that the annual maxima of Victoria and Albert, for which latter lake gauges also exist, are not contemporaneous. The most important variation is that which is shown to be in sympathy with sunspots. This correspondence is exhibited in a striking plate in which five curves appear for the period 1896–1922: (1) and (2) maximum and minimum readings of the lake-gauge on lake Victoria in inches above zero level; (3) rainfall in Uganda, deviations from normal summed in overlapping periods of six months; (4) monthly sunspot numbers; (5) mean level of lake Albert in inches above zero level. The sunspot relation is demonstrated to be outstanding, and so greatly do the long-period changes exceed the annual variation in magnitude that no correction is applied for annual range to the figures on which the curves are based. The level of lake Victoria is higher by some 60 inches at times of sunspot maxima (with a lag of one to two months), and the eleven-year period which is, of course, prominent in curve 4 is faithfully reflected in 1 and 2. Lake Albert is more variable in level than Victoria, the total range exceeding 160 inches, but it too exhibits the sunspot relation. The direct correlation coefficient between the Victoria lake-level and sunspot numbers is +0·81, between lake-level and rainfall only +0·29, while the corresponding partial coefficients are +0·82 (allowance being made for rainfall) and +0·39 (with allowance for sunspots).

From the monthly coefficients Brooks deduces the equation $L = 0{\cdot}36R \times 0{\cdot}36S$, where L is departure in inches of lake-level from normal for the month, R departure from normal in inches of general rainfall over Uganda in six months, and S departure of relative sunspot numbers from the average (35). From the study of data for the outflow from the lake at Ripon Falls he calculates that the run-off is only 6 per cent. of the rainfall of the basin, the remaining 94 per cent. representing evaporation from soil, vegetation, and lake surface.

By means of the above equation it can be shown that, owing to increased evaporation, run-off, and seepage, an excess of rainfall above the average would have comparatively little effect in raising the lake-level. This indicates that evaporation over the drainage basin is to some extent proportional to the rainfall, as it might well be in this type of climate, but is chiefly related to the

sunspot frequency. The physical link is probably temperature, which, as Köppen has shown, averages in the tropics 1·1° F. higher at spot minimum (low lake-level) than at maximum. Evaporation is therefore the governing factor, representing a much greater cause of loss than run-off, and probably still more than seepage.

**Italian Expedition in Northern Eritrea.**

We referred some time ago (*Journal*, vol. **61**, 1923, p. 148) to an expedition for topographical, zoological, botanical, and other scientific research organized in 1922 by Signors Corni, Calciati, and Bracciani, who chose northern Eritrea as their field of work, particularly the imperfectly known districts between the Gash and the Setit. We have lately received a typewritten report on the results of the expedition, which, though lasting for little over three months (December 1922 to March 1923), seems to have carried out its programme successfully and to have brought home valuable observations and collections. From Massawa the party went by rail to Keren, where a caravan for the south was organized, and the special field of exploration was reached by way of Agordat and Barentu. (These places will be found on the sketch-map in the January number illustrating Major Maydon's journey, which touched part of the same ground in the same year.) The journey involved some hardships by reason of the heat and the waterless nature of much of the country, which sometimes necessitated forced marches. It has suffered severely from the merciless Abyssinian raids, so that in parts the scanty population has been forced to migrate. During the journey a compass traverse was carried out, and a network of bearings was obtained by ascending many of the isolated peaks, some of which offer widely extended views. The result has been to correct the map in many particulars, and fill in details in parts that were blank before. The Italian-Abyssinian frontier is quite unsurveyed in this region, and its course as understood in the country itself differs considerably from that shown on existing maps. Careful observations of the geology were also made, and near the Gash a limestone deposit capable of yielding good building stone was found, although most of the formations are crystalline. Ethnological notes and collections were made among the various branches of the Kunama and other tribes encountered. Some of the soil would be exceedingly fertile were it not for the absence of water.

## AUSTRALASIA AND PACIFIC ISLANDS

**Forests of New Zealand.**

The following statement on the position of New Zealand forestry is abstracted from 'Forests and Forestry in New Zealand,' prepared for the Imperial Forestry Conference, Ottawa, 1923 (Wellington, N.Z., 1923). Of the whole area of the Dominion, 9 per cent. is covered by merchantable timber, and an equal area by inaccessible timber. Four main regions are distinguished: (1) a northern warm region, producing Kauri and other soft woods; (2) western and southern foothills, with rain forests principally of Rimu and Kahikatea types; (3) an eastern dry region with *Nothofagus* forests, of which beeches are the chief constituent; and (4) the upland division of Rata forests, chiefly used for fuel. The Kauri is the timber of greatest commercial value, but exploitation has reduced it almost to vanishing point. The chief soft wood is Rimu, now most used for constructional purposes. Present resources are estimated at 3800 million cubic feet. Beech is the chief hard wood; its resources are placed at 2700 million cubic feet. About 78 per cent. of the forest area is owned

by the State, 12 per cent. by natives, and 5½ per cent. by others, the remainder being leasehold. The Government, through the Minister of Forestry, has done much to safeguard the future, by encouragement of economic management, the planting of protective forests, afforestation, research, and general propaganda. The Forest Authority is entrusted with all matters of forest policy, including the granting and supervision of leases, permits, and licences. Two of the great dangers to be guarded against are the deer pest and the outbreak of fire. The Forest income for 1923 is given as £63,372, as against an expenditure, capital and operational, of £85,410. The average annual utilization of the forest is given as 106 million cubic feet, with a value at the place of preparation of about £2,000,000. The chief forest industry is timber manufacture. In 1922, 27 million cubic feet of sawn timber was produced, to the value of approximately £4,000,000. Most of the timber exported is absorbed by Australia and the Pacific Islands. A considerable amount is still imported: against approximately 5 million cubic feet of soft woods exported, 610,000 cubic feet are imported, and against 100,000 cubic feet of hard woods exported, over 1 million cubic feet are imported. Of the imports, just under half come from other parts of the British Empire. Of the minor forest products exported, Kauri gum is the most important. In the same class, tanning bark and wood pulp are imported, though it is hoped that the internal supply will soon meet the demand. It is estimated that at the present rate of consumption, the visible supplies of forest produce will be exhausted in thirty-five to forty-five years.

## MATHEMATICAL AND PHYSICAL GEOGRAPHY

### The Evolution of Lapies.

An article by Dr. Jovan Cvijić, which appears in the *Geographical Review* for January 1924 (vol. 14, No. 1, p. 26), deals with the regions of lapies, "surfaces covered by a network of furrows and crests well avoided by man and beast." It is a welcome contribution from one of the greatest students of Karst topography, not only adding to our fund of knowledge about the various types and occurrences of Karst land-forms, but also suggesting the origin and evolution of this particular form, a piece of constructive work which has not been seriously attempted before. The article begins with a careful description of the different varieties of lapies, illustrated by a series of excellent photographs. Dr. Cvijić as a rule adopts the local names current in the Dinaric region to designate the different varieties, but he also gives the French and German equivalents, which not only makes for clearness, but will also be an enormous help to those who follow him up in studying such regions. Actual measurements of the dimensions of the different forms, as well as the names of places where each may be found, will also help in field work on what is undoubtedly a very difficult region.

The origin and evolution of the lapies are dealt with in the latter part of the article. Chemical erosion of the limestone surface is the principal factor, although mechanical erosion plays a minor rôle.* The composition of the limestone, its slope and vegetation, and above all its fissures, are the factors which combine to form the different varieties of lapies surface. The stages in the evolution are made exceedingly clear by a series of excellent diagrams.

* The French cave-explorer, M. E. A. Martel, was inclined to assign a preponderating rôle to erosion by running water (see *Journal*, vol. 21, p. 328).—ED. *G J.*

The first stage shows shallow channels separated by low sharp-pointed ridges, or else the honeycomb variety. In the fully developed lapies the relief is at its maximum, the channels are from 3 to 4 metres deep, while both depression and intervening ridge develop characteristic hollows. The next stage shows the beginning of the process which lessens the relief; the narrower ridges spall, their number is reduced, the channels between them are wider, some of the hollows begin to be filled by stones. The cycle ends with the almost complete disappearance of the ridges, only remnants surviving; the former lapies surface is buried beneath blocks formed by the spalling of the ridges; often the heaps of stones are covered by soil and some vegetation can exist. A cycle may be interrupted by the existence of a bed of impermeable strata among the limestone, but as a rule the process does not stop until that layer of limestone is reached which is permanently saturated by a network of the underground sheet of water.

## GENERAL

### The Olympic Prize for Alpine Climbing.

On the day before he sailed for India to lead the Third Mount Everest Expedition General Bruce received a letter from the General Secretary of the *Comité Olympique Français* inviting him to Chamonix to receive the *Prix d'Alpinisme*, which had been unanimously awarded to him by the *Comité International Olympique* and the *Comité Olympique Français*. The two Committees were of the opinion that no individual or collective effort had in the last four years equalled that which General Bruce and his comrades had achieved in the Mount Everest Expedition, and at the closing ceremony of the *Jeux d'Hiver* the assembled athletes of nineteen nations would be happy to acclaim in him the most magnificent example of energy which the Committee could set before them.

Since it was impossible for General Bruce to attend in person, the Mount Everest Committee nominated Lieut.-Colonel E. L. Strutt, the Second-in-Command of the Expedition of 1922, to represent the Expedition, and at a great assembly on the Skating Rink at Chamonix on February 5 thirteen handsome silver-gilt medals were handed to him, one for each British member of the party. Monsieur le Baron Pierre Coubertin, President of the *Comite International Olympique*, in an eloquent speech referred in most flattering terms to the hardships undergone by the party, and expressed his sincere hopes for the success of General Bruce and the Expedition of 1924. The Baron also referred to the fact that this was the first occasion on which the Olympic prize had ever been awarded for a mountaineering feat, and expressed the hope that General Bruce would see that one of these medals was deposited on the summit of Mount Everest this year. The speech was received with loud cheers from the Olympic competitors and spectators numbering several thousands, and the band of the 27th Chasseurs Alpins played the British National Anthem as Colonel Strutt advanced to receive the prize.

The Mount Everest Committee have conveyed to the Presidents of the *Comité International Olympique* and the *Comité Olympique Français* their high appreciation of the distinction conferred upon General Bruce and the members of the Expedition by this award.

### New Secretary of the Royal Danish Geographical Society.

We are informed that Prof. Olufsen, well known for his journeys of research in the Pamirs, and long the efficient secretary of the Royal Danish

Geographical Society, has lately retired from that office. His successor is Major-General Cartonier.

**International Congress of American History and Geography.**

In conformity with a resolution of the first Congress of Argentine history held in 1922, the American Academy of History is organizing an International Congress of History and Geography, to meet at Buenos Aires on 12 October 1924. The inauguration of such a Congress in connection with the Brazilian celebration of 1922 was referred to in the *Journal*, vol. 58, p. 149, where some account was given of the elaborate programme put forward. It would appear, though this is not directly stated in the circular of invitation received, that the meeting this year is the outcome of that original scheme. The Argentine Geographical Institute is collaborating with the above-mentioned Academy in the arrangements for the meeting, with special regard to the Geographical Section, which will concern itself both with the various branches of general geography and with the progress of geography and exploration in each American state, as well as with the various economic questions affecting the same.

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## OBITUARY

### Prof. F. Omori.

PROF. FUSAKICHI OMORI, the well-known Japanese seismologist, died at Tokyo on November 8 last, at the age of fifty-five. On the death of Prof. S. Sekiya in 1896, Omori succeeded him as professor of seismology in the Imperial University at Tokyo, and served as secretary to the Imperial Earthquake Investigation Committee until shortly before his death, when he became president. There are few, if any, branches of seismology to which Prof. Omori did not contribute during his busy life. His memoir on the after-shocks of earthquakes, a subject to which he always returned with interest, first brought him into prominent notice. He invented a mechanically recording horizontal pendulum, which is widely used in Japan and elsewhere. He is perhaps best known for his valuable studies of Japanese earthquakes and volcanic eruptions, especially of the distribution of earthquakes in space and time, and recently he made several estimates of the depths of their foci based on the duration of the preliminary tremor and the distance of the epicentre. His important series of memoirs on the eruptions of the Usu-san, Asamayama, and Sakura-jima have been frequently noticed in these pages. His death, just at the time when the investigation of the great earthquake required his skilful guidance, is a misfortune to seismology. C. D.

### Captain Alfred Bertrand.

We regret to record the death of Captain Alfred Bertrand of Geneva, for many years an Hon. Corresponding Member of this Society, who became known to geographers in the last decade of last century for his journeys in Barotse-land, when that region still offered some untrodden ground to the explorer. One of these journeys was described by the traveller in the *Journal*, vol. 9, pp. 145 *et seq.* His general account of his travels in South Africa, published in 1898 under the title 'Aux pays des Ba-Rotsi,' appeared the

next year in an English translation, and in that year he also brought out a second volume in French, entitled 'En Afrique avec le Missionnaire Coillard.'

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## MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1923–1924

**Sixth Evening Meeting, 28 January 1924.**—The President in the Chair.

ELECTIONS.—Miss Mabel E. Ascroft; Sidney Edward James Best, B.SC.; Evan E. Biss; Major James John Bramble; John Alexander Broun, C.S.I., V.D.; William Carse, M.A.; William Cross; Cecil Frederick Dadley; Douglas Dunlop, LL.D.; Mrs. Beatrice Erskine; Miss Nellie Mitchell Fairweather; Alan David Francis, B.A.; Col. Herbert Thomas Goodland, D.S.O.; Neville Aldridge Holdaway, B.S.C., M.C.; Percy C. Hutchence; Major A. W. Johns, R.A.S.C.; The Lady Evelyn Lister; Harry Hawksby Lowther; Henry Simpson McClelland, B.A., B.D.; H. M. Macintyre; Rev. George Kynoch Moir; Charles M. Morrell; Victor Coverley Price; Alexander Moir Robb, M.A.; Lieut. George Edward Ewart Rowe (Royal Tank Corps); Charles Frederick Rymer; William H. Saunders, F.C.S.; A. G. H. Sievwright; James King Steele; Capt. J. Teague, M.C., I.A.; George Arthur Toplis; Claude Henry Tritton; William Robert Warner, M.A.; Rev. Frank Yates.

PAPER: The Tocantins and Araguaya Rivers, Brazil. S. C. Bullock.

**Seventh Evening Meeting, 11 February 1924.**—The President in the Chair.

ELECTIONS.—Anthony J. Bertuchi; Norman Blythman; Claude Ebbetts Bridges; Norman Croom-Johnson; Capt. Richard Clarke Dene; Miss Gertrude Emerson, PH.B.; Lieut. Victor Alexander Charles Findlay; Lieut.-Colonel Victor Anderson Haddick; Mrs. Margaret Masson Hasluck; Thomas R. Horner; Sidney Rowland Hudson; Miss Evelyn M. Hunt; Percival Charles Ingram; Charles Billyard Leake, J.P.; Lady Mackay; Mrs. Maria Nelke; Commr. Ralph Neville; Michael John O'Riordan; J. Aubrey Rees; Henry James Saban, M.C., B.A.; Mrs. Beatrice E. Smythe; James A. Storer; John William Thorogood, M.A., B.SC.; Edgar Turley; Capt. William Tutton; Dr. Yih S. Wan, M.A., M.B., B.SC.; Leslie George Walsh White; Mrs. Alice Williamson.

PAPER: Persian Azerbaijan and the Western Elburz. Capt. L. S. Fortescue.

**Fourth Afternoon Meeting, 18 February 1924.**—The President in the Chair.

PAPER: The Use of Watermarks in dating Old Maps and Documents. E. Heawood.